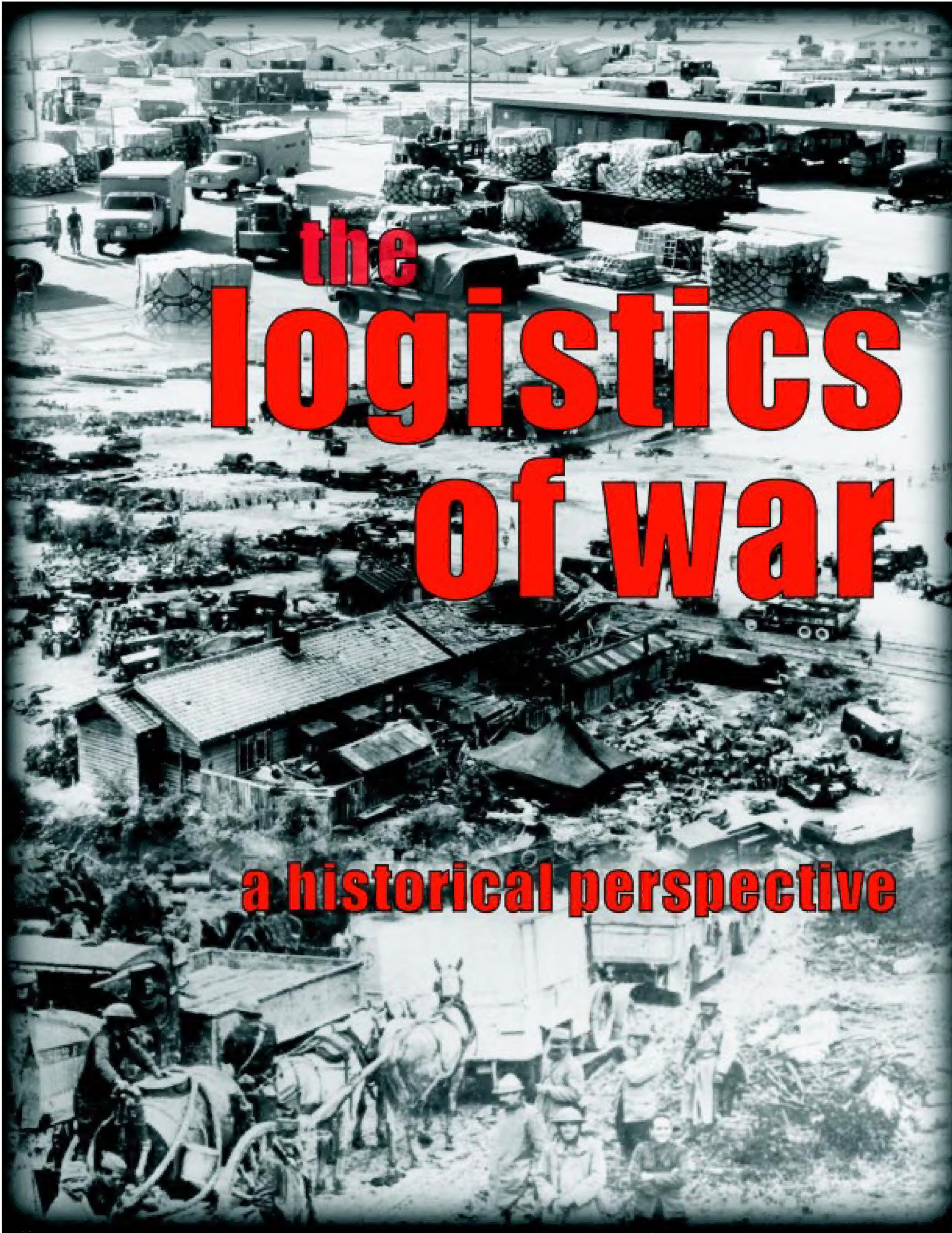
the logistics of war

a historical perspective



the logistics of war

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Preface

> *Surely one of the strangest things in military history is the almost complete silence upon the problem of supply.*
>
> *The Lifeblood of War*

Understanding the elements of military power requires more than a passing knowledge of logistics and how it influences and, in many cases, dictates strategy and tactics. **An understanding of logistics comes principally from the study of history and the lessons that history offers.** Unfortunately, despite its undeniable importance, surprisingly little emphasis is placed on the study of history among logisticians and the lessons to be found and studied. To compound matters, the literature of warfare is replete with triumphs and tragedy, strategy and tactics, and brilliance or blunders; however, far less has been written concerning logistics and the tasks involved in supplying war or military operations.[1]

General Mathew B. Ridgeway once observed, "What throws you in combat is rarely the fact that your tactical scheme was wrong . . . but that you failed to think through the hard cold facts of logistics." The general's message is important—logistics is the key element in warfare, more so in the 21st century than ever before. Without question, success on the modern battlefield is dictated by how well the commander manages available logistical support. The victories by the United States in three major wars (and several minor wars or conflicts) since the turn of the century are far more directly linked to the ability to mobilize and bring to bear economic and industrial power than any particular level of strategic or tactical design. The Gulf War further illustrates this point.

> As the machinery of the Allied Coalition began to turn, armchair warrior addicted to action, and even some of the hastily recruited military experts, revealed a certain morbid impatience for the "real war" to begin. But long before the Allied offensive could start, professional logistician's had to gather and transport men and materiel and provide for the sustained flow of supplies and equipment that throughout history has made possible the conduct of war. Commanders and their staffs inventoried their stocks, essayed the kind and quantities of equipment and supplies required for operations in the severe desert climate, and coordinated their movement plans with national and international logistics networks. **The first victory in the Persian Gulf War was getting the forces there and making certain they had what they required to fight [Emphasis added].** Then and only then, would commanders initiate offensive operations.[2]

From a historical perspective, ten major themes stand out in modern US military logistics.

- The tendency to neglect logistics in peacetime and to expand hastily to respond to military situations or conflict.
- The increasing importance of logistics in terms of strategy and tactics. Since the turn of the century logistical considerations have increasingly dominated both the formulation and execution of strategy and tactics.
- The growth in both complexity and scale of logistics in the 20th century. Rapid advances in technology and the speed and lethality associated with modern warfare have increased both the complexity and scale of logistics support.
- The need for cooperative logistics to support allied or coalition warfare. Virtually every war involving US forces since World War I has involved providing or, in some cases, receiving logistics support from allies or coalition partners. In peacetime, there has been an increasing reliance on host nation support and burden sharing.
- Increasing specialization in logistics. The demands of modern warfare have driven an increasing level of specialization among support forces.
- The growing tooth-to-tail ratio and logistics footprint issues associated with modern warfare. Modern, complex, mechanized, and technologically sophisticated military forces capable of operating in every conceivable worldwide environment require

that a significant portion, if not the majority of it, be dedicated to providing logistics support to a relatively small operational component. At odds with this is the need to reduce the logistics footprint in order to achieve the rapid project of military power.

- The increasing number of civilians needed to provide adequate logistics support to military forces. Two subthemes dominate this area: first, unlike the first half of the 20th century, less reliance on the use of uniformed military logistics personnel and, second, the increasing importance of civilians in senior management positions.
- The centralization of logistics planning functions and a parallel effort to increase efficiency by organizing along functional rather than commodity lines.
- The application of civilian business processes and just-in-time delivery principles, coupled with the elimination of large stocks of spares.
- Competitive sourcing and privatization initiatives that replace traditional military logistics support with support from the private business sector.

In 1904, Secretary of War Elihu Root warned, "Our trouble will never be in raising soldiers. Our trouble will always be the limit of possibility in transporting, clothing, arming, feeding, and caring for our soldiers . . . ."[3] Unfortunately, the historical tendency of both the political and military leadership to neglect logistics activities in peacetime and to expand and improve them hastily once conflict has broken out may not be so possible in the future as it has in the past. A declining industrial base, flat or declining defense budgets, force drawdowns, and base closures have all contributed to eliminating or restricting the infrastructure that made rapid expansion possible. Regardless, modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment. All these commodities must be produced, purchased, transported, and distributed to military forces. And of course, the means to do this must be sustained. Arguably, logistics of the 21st century will remain, in the words of one irreverent World War II supply officer, "the stuff that if you don't have enough of, the war will not be won as soon as."[4]

Interestingly, the word logistics entered the American lexicon little more than a century ago. Since that time, professional soldiers, military historians, and military theorists have had a great deal of difficulty agreeing on its precise definition.[5] Even today, the meaning of logistics can be somewhat *fuzzy* in spite of its frequent usage in official publications and its lengthy definition in Service and joint regulations. The eminent historian Stanley Falk describes logistics on two levels. First, at the intermediate level:

> Logistics is essentially moving, supplying, and maintaining military forces. It is basic to the ability of armies, fleets, and air forces to operate—indeed to exist. It involves men and materiel, transportation, quarters, depots, communications, evacuation and hospitalization, personnel replacement, service, and administration.

Second, at a higher level, logistics is:

> . . . economics of warfare, including industrial mobilization, research and development, funding procurement, recruitment and training, testing and, in effect, practically everything related to military activities besides strategy and tactics.[6]

While there are certainly other definitions of logistics (many are contained in this book), Falk's encompassing definition and approach provides an ideal backdrop from which to examine logistics from a historical perspective.

Notes

1. John A. Lynn, ed., *Feeding Mars: Logistics in Western Warfare From the Middle Ages to the Present*, San Francisco: Westview Press, 1993, vii.
2. Charles R. Shrader, *U.S. Military Logistics, 1607-1991, A Research Guide*, New York: Greenwood Press, 1992, 3.
3. Shrader, 9.
4. Julian Thompson, *The Lifeblood of War: Logistics in Armed Conflict*, Oxford: Brassy's. 1991, 3.
5. George C. Thorpe, *Pure Logistics*, Washington DC: National Defense University Press, 1987, xi.
6. Alan Gropman, ed., The Big L: American Logistics in World War II, Washington DC: National Defense University Press, 1997, xiii.

Introduction

The *Logistics of War* is a collection of three works that examine both broadly and specifically the history of US military logistics: *The Logistics of Waging War—American Logistics, 1774-1985—Emphasizing the Development of Airpower*, *The Logistics of Waging War—US Military Logistics 1982-1993—The End of Brute Force Logistics*, and the History of US Military Logistics: 1935-1985, A Brief Review. *The Logistics of Waging War—American Logistics, 1774-1985—Emphasizing the Development of Airpower* was originally published by the Air Force Logistics Management Agency as part of Project Warrior. While retaining its original character, this work has been extensively edited, reorganized, and two new sections added: "The Logistics Constant Throughout the Ages" and "General Logistics Paradigm: A Study of the Logistics of Alexander, Napoleon, Sherman." Readers of the old work will find this new version easy to navigate through and bit more *user friendly*. *The Logistics of Waging War—US Military Logistics 1982-1993—The End of Brute Force Logistics*, also originally published by the Air Force Logistics Management Agency, has likewise been extensively edited and updated. The final work is Jerome G. Peppers', Jr, seminal work on the history of US military logistics. While there is some overlap between the three works, the reader will find this enhances the historical record because of the level of detail, different styles, and approaches used by the various editors and authors.

The *Logistics of War* provides today's military logistician with a tool to see how past logisticians faced the greatest challenges brought forth by the pressures of war. It also provides the military logistician with a ready historical reference. *The Logistics of War* will also stimulate interest and thought and answer questions such as What? Why? and How?

Acknowledgments

Many people were involved with the development and production of *The Logistics of War*; however, several deserve special acknowledgement. This book could not have been produced without their work, efforts, help, and advice.

Contributing Editors: Lieutenant Colonel Gail Waller and Captain Patrick K. Pezoulas
Administrative Support: Jessica Harris, Patricia G. Tracy, and William R. Burell

We are deeply indebted to Colonel Richard M. Bereit and Colonel Ronne G. Mercer, past and present commanders of the Air Force Logistics Management Agency, for their support in developing and producing *The Logistics of War*.

Original Publications

The Logistics of Waging War—American Logistics, 1774-1985—Emphasizing the Development of Air Power
Editors: Lieutenant Colonel David C. Rutenberg and Jane S. Allen
New Contributing Authors: Cadet First Class Daniel McConnell, Captain Richard A. Hardemon, and Master Sergeant Larry C. Ransburgh

The Logistics of Waging War—US Military Logistics 1982-1993—The End of Brute Force Logistics
Writers and Editors: Captain Thomas J. Snyder and Captain Stella T. Smith
Executive Editor: Lieutenant Colonel Brent S. Smeltzer
Editor: Chief Master Sergeant Manley F. Adams
Administrative and Graphics Support: Patricia G. Tracy

The History of US Military Logistics: 1935-1985, A Brief Review
Author: Jerome G. Peppers, Jr
We are deeply appreciative to Jerome G. Peppers, Jr, Professor Emeritus, Air Force Institute of Technology, for graciously reassigning the copyrights to his work and allowing us to include it in this book. This is truly one of the seminal works in the history of logistics and was a most valuable addition to *The Logistics of War*.

THE LOGISTICS OF WAGING WAR

Emphasizing the Development of Airpower

Why Study Logistics?

Is logistics simply a science of detail? Or, on the contrary, is it a general science, forming one of the most essential parts of the art of war? Or, is it but a term consecrated by long use, intended to designate collectively the different branches of staff duty—that is to say, the different means of carrying out in practice the theoretical combinations of the art?

These questions will seem singular to those persons who are firmly convinced that nothing more remains to be said about the art of war and believe it wrong to search out new definitions where everything seems already accurately classified. For my own part, I am persuaded that good definitions lead to clear ideas, and I acknowledge some embarrassment in answering these questions, which seem so simple.

In the earlier editions of this work, I followed the example of other military writers and called by the name of *logistics* the details of staff duties, which are the subject of regulations for field service and of special instructions relating to the corps of quartermasters. This was the result of prejudices consecrated by time. The word *logistics* is derived, as we know, from the title of the *major general des logis* (translated in German as Quartermeister), an officer whose duty it formerly was to lodge and camp the troops, to give direction to the marches of columns, and to locate them upon the ground. Logistics was then quite limited.

But when war began to be waged without camps, movements became more complicated, and the staff officers had more extended functions. The chief of staff began to perform the duty of transmitting the conceptions of the general to the most distant points of the theater of war and of procuring for him the necessary documents for arranging plans of operations. The chief of staff was called to the assistance of the general in arranging his plans, to give information of them to subordinates in orders and instructions, to explain them, and to supervise their execution both in their ensemble and in their minute details; his duties were, therefore, evidently connected with all the operations of a campaign.

To be a good chief of staff, it became in this way necessary that a man should be acquainted with all the various branches of the art of war. If the term *logistics* includes all this, the two works of the Archduke Charles, the voluminous treaties of Guibert, Laroche-Ayon, Bousmard, and Ternay, all taken together, would hardly give even an incomplete sketch of what logistics is; for it would be nothing more nor less than the science of applying all possible military knowledge.

Baron de Jomini
The Art of War, 1838

Introduction

More than most professions, the military is forced to depend on intelligent interpretation of the past for signposts charting the future. Devoid of opportunity, in peace, for self-instruction through actual practice in his profession, the soldier makes maximum use of historical record in assuring the readiness of himself and his command to function efficiently in emergency. The facts derived from historical analysis, he applies to conditions of the present and the proximate future, thus developing synthesis of appropriate method organization and doctrine.

General Douglas MacArthur

In all war situations, the actions and decisions of command, whatever the level, are based on a blend of strategical, logistical, and tactical plans.

Rear Admiral Henry E. Eccles

In the literature of military history, there is no shortage of material dealing with the strategic and tactical decisions that have led nations and commanders to victory and defeat. Too often, though, the chronicles of battle tend to resemble a gigantic board game, with commanders seemingly able to move their forces and resources about at will—feinting, encircling, massing, and thrusting toward their objectives. A close examination, however, reveals that, throughout the history of warfare, crucial strategic and tactical decisions were often direct reflections of the logistical needs and capabilities of opposing armies. There is no reason to suspect that this will change in the future, yet the literature addressing it is presently sparse and scattered.

Aggravating the lack of a written record documenting the logistical dimension of US wars is the fact that more than half the officers and enlisted members of today's military services joined the ranks since the United States ended its involvement in Vietnam. These future leaders have no direct combat experience. An understanding of how Americans have previously met the tremendous demands of wartime logistical support can serve as a rock bed for meeting the defense challenges that may lie ahead.

This history was conceived and written based on the premise that knowledge of the past sharpens the warrior's perceptions and ability to deal effectively with the future. Yet the temptation to draw lessons and apply them to modern questions of warfare was vigorously resisted. The twin dangers of misinterpreting events and misapplying lessons have more than once turned valuable historical research into misguided advocacy.

Two connective threads, though, are worth identifying, as they serve to validate the very need for research into historical logistics. First, it is abundantly clear that the availability of raw logistical capability—massive tonnage of appropriate kinds of war materiel produced and moved rapidly to the war zone—has done much to determine the potential for victory or defeat throughout US military history. This has been true across the spectrum of conflict—from wars of worldwide magnitude to conflicts of significantly more limited scale. Second, the wisdom and cunning with which this logistical capability has been synchronized with strategies and tactics were key factors in the location, timing, tempo, and outcome of many of the US history's most critical military engagements. Hopefully, this work will promote a greater understanding of this dynamic interaction.

It is impossible to do more than scratch the surface in a study of this size. The authors strove to distill significant characteristics, trends, events, and examples to accurately portray the development of logistical thought, doctrine, and technique. But a work of so limited proportion could hardly be *definitive*. There is opportunity and need for far deeper and more reflective research and writing with respect to the impact of logistics on war. To aid those who would delve more deeply, we have provided generous referencing to a large bibliography of source publications. To assist readers in assessing the development of more specific areas, we have standardized chapters to deal with five basic aspects of logistics: how the industrial base supported the war, how requirements were determined, how military assets were *acquired,* how they were distributed, and how they were *maintained* in a ready state.

Logistics Through the Ages

Logistics has often been defined as the art and science of moving armies and keeping them supplied. General Antoine Henri de Jomini, a Swiss authority on strategy following the Napoleonic Wars, was perhaps the first to formally recognize and write specifically about the importance of logistics (1:741). In his book, *The Art of War*, he defines logistics as the "practical art of moving armies" (3:132). Jomini goes on to discuss relationships between strategy, tactics, and logistics. All three areas are important, and the slighting of any one has often spelled the difference between success and failure on the battlefield. This study illustrates how logistics has historically been an integral factor in US military operations. However,

before looking at the US military, we must place the American experience in historical perspective by reviewing how logistics evolved prior to the American Revolution.

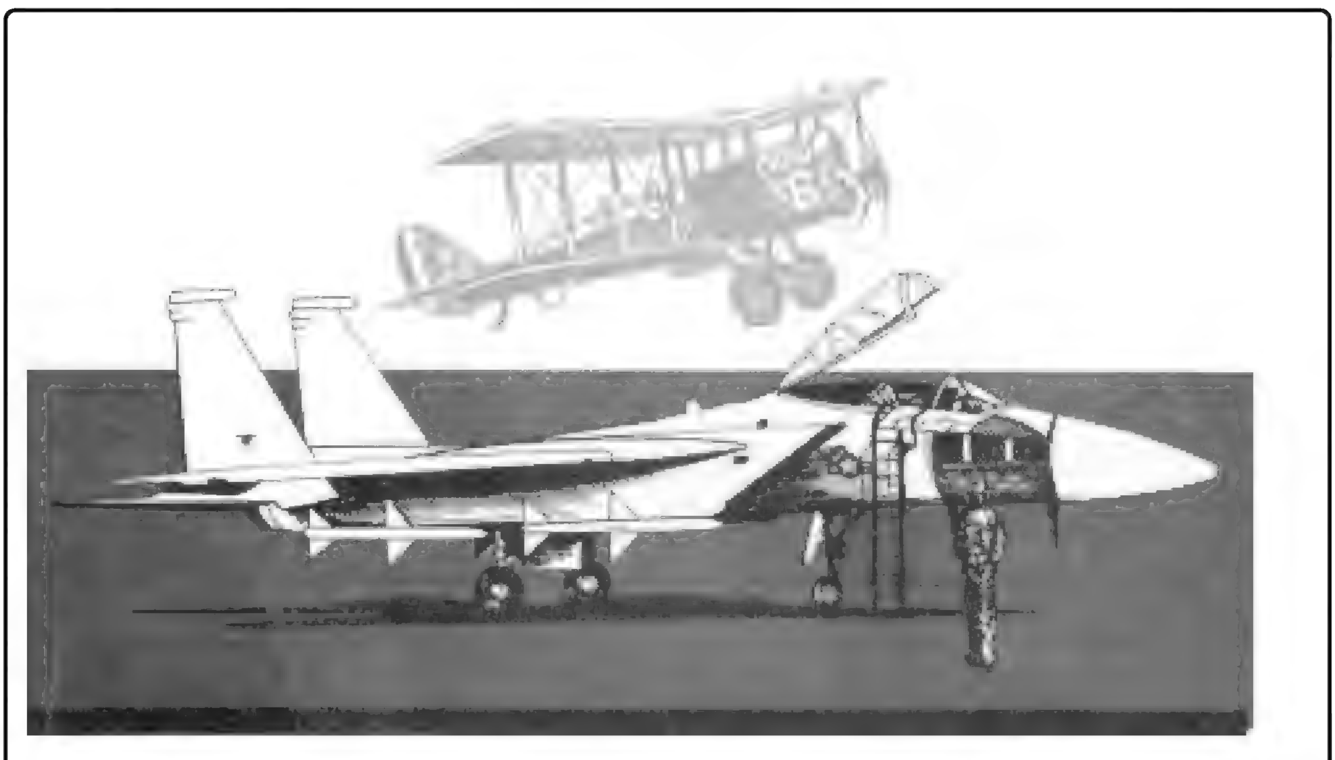
Although there was little written about logistics prior to Jomini, since ancient times armies have had to rely upon logistics to feed their troops and livestock and provide their battle weapons. As early as 500 BC, Sun Tzu Wu referred to logistical functions and their relationships with strategy and tactics. The armies of Sun Tzu Wu's time lived off the land or brought with them whatever supplies they required. Consequently, logistics was accomplished without a great deal of preplanning. Alexander the Great was perhaps the first to develop a logistics system to support his Macedonian troops. His staff officers included quartermasters (QM) and subsistence officers who supervised the army's baggage train, which was organized on the basis of one mounted slave with a packhorse for each cavalryman and a slave on foot with a packhorse for every ten infantrymen (1:741).

The Romans used a method whereby every soldier was loaded down with 50 to 85 pounds of supplies in order to reduce the size of the baggage train. Even then, each Roman legion had a baggage train of 520 pack animals carrying tent poles, officers' tentage and baggage, heavy tools and other engineering equipment, and reserve rations (1:741). The Romans also used supply depots stationed throughout the region at 16-mile intervals (1 day's march for the army). The depots were stocked with local food and fodder and were fortified against attack. After the fall of the Roman Empire, the Byzantine Empire of 600 AD was organized into military districts, and each district had its own cavalry force along with engineers, supply trains, and medical services (2:78). Thereafter, the importance of logistics considerations seemed to diminish temporarily.

During the Middle Ages in Europe, there were no national armies. Feudal lords and kings did not have the funds to equip large standing armies. Thus, small armies were raised when required and lived off the land as best they could. During the Thirty Years' War (1618-1648), central Europe was devastated as these undisciplined armies literally raped the countryside. Following the Thirty Years' War, the Marquis de Louvois, war minister of Louis XIV of France, introduced a commissariat service to supply the needs of the French Army. Along with this service, a system of wagon trains was developed based on a magazine concept. Unfortunately, this system restricted the speed and mobility of the army (2:78). Defense—or the capture of magazines—now became the goal of opposing armies. "The supply and maintenance of armies had become the master of strategy instead of its servant" (2:78).

A combination of the magazine system, long wagon trains, and living off the countryside was used during the 17th and 18th centuries. Wars were limited in nature, and it was not until the rise of Napoleon that the *total war* concept blossomed. Bonaparte's attention to logistics was extraordinary, and it was predominantly his preplanning and respect for support factors that allowed him to move and maneuver with such stunning agility.

This study begins in the middle of the 18th century and looks at the development of logistical thought and technique and how they affected the course of various campaigns of the American military.



Foundations of Military History

Alexander—the Great Logistician

The major problems in attempting to understand the logistics system of the Macedonian Army are not only the almost complete lack of interest by our sources in its functioning but also the fact that Alexander so capably directed its operation that logistics scarcely seems to have affected any of his strategic decisions. Yet a deeper analysis shows this latter view to be false. Supply was indeed the basis of Alexander's strategy; and when the climate, human, and physical calendar of a given region are known, one can often determine what Alexander's next move will be.

The Macedonians' logistics organization, developed by Philip, was fundamentally different from that of contemporary Greek and Persian armies. In Greek armies, the number of followers often approached the number of combatants; and servants or baggage animals carried rations, arms, and armor. Philip trained his soldiers to carry their full panoply as well as provisions, and he forbade cars and women to accompany the army. Much equipment was carried by a limited number of servants rather than by carts or pack animals. The consequence of Philip's reforms, which were continued as far as possible by Alexander, was a dramatic reduction in the size of the baggage train. This had a momentous effect. It made the Macedonian Army the fastest, lightest, and most mobile force in existence, capable of making lightning strikes "before anyone had time to fear the event." Alexander's astonishing speed, which so terrified his opponents, was due in no small part to Philip's reforms. Because many supplies were carried by the troops and a restricted number of servants, the Macedonian Army needed far fewer pack animals than other contemporary forces, which reduced the problems of acquiring sufficient animals and feeding them among populations engaged in subsistence agriculture. In short, the logistics organization of Alexander's army was brilliantly adapted for campaigning in Asia, where the acquisition of pack animals and provisions was often difficult in barren terrain and where speed and mobility were important tactical advantages.

The two most significant obstacles to supplying the army were the limited capabilities of overland transportation and the subsistence level of most agricultural production in antiquity (which in turn was caused in large part by a lack of efficient transport). Because of the limitations of transport, the army could not remain self-sufficient for long distances when remote from navigable rivers or seaports. Hence, arrangements for the army's supply were made in advance with local officials, who regularly surrendered to Alexander before he entered their territory. In regions where local geographical conditions made the acquisition of supplies particularly difficult, Alexander would often take hostages or establish garrisons to ensure their efficient collection. When he entered the Iranian heartland, however, few surrendered to him in advance, and the army's provisioning problems were intensified. Alexander would never commit his entire army for a campaign into a region that had not surrendered to him in advance. Instead, he would first obtain intelligence concerning the routes, climate, and resources of the country and then strike out with a small, light force, while the main army remained behind at a base well supplied with provisions. Alternatively, he would divide the army into smaller units so their diminished requirements could be more easily provided during their advance through the countryside. Supplies at such times would not be provided by markets, gifts, or requisitions as before but by pillaging towns and villages or by foraging. Advance intelligence was always an essential factor in Alexander's successful operations.

Professor Donald W. Engels, Wellesley College
Alexander the Great and the Logistics of the Macedonian Army

Great Fighters Are Great Logisticians

It is said that Ghengis Khan looked for men of endurance, ones who were sullen, fatalistic, phlegmatic, and callous—ones who suffered without complaint and killed without pity. Each of these delightful creatures wore, besides tunics and trousers, a long, loose raw silk undergarment—any arrow that hit usually carried the silk into the wound making removal easy and the wound more likely to heal. The Mongol crossbow was marvelous—a pull of 100-160 pounds (English longbows had 75-pound pull), made from layers of horn and sinew on a waterproof wooden frame. Velocity increased using the Mongolian thumb lock—a stone ring worn on the right thumb, which was used to draw back the bowstring for faster releases. It worked! He had arrows for every purpose: long-, short-ranged, 3-foot armor piercing ones, whistling arrows, incendiary arrows, and arrows tipped with tiny grenades. He worked his bow in the saddle, aiming between paces of his horse so pounding hooves would not deflect his aim.

The horse he rode was also magnificent—almost prehistoric, 16 hands tall, battle trained for 3 years. On the march, each man had three mounts. Mongol horses were better cared for than any other horses in history. A dead trooper was always buried with his favorite horse.

Men learned precision and maneuvers as teenagers. It was law for teenage boys to be instructed in archery and horsemanship. But the most important law—the one that prescribed the great hunt, a peacetime campaign held at the start of winter—lasted till spring. In a great line, the entire army moved forward, pushing all game before it for hundreds of miles. Any trooper who let an animal escape had failed, and both he and his commanding officer were punished. Wild boar and wolf packs violently attacked the troopers. After many miles, a circle would be formed, racing deer were run after, tigers were killed with bare hands, other animals were more conventionally slaughtered for food, and the Khan usually released the others. For 800 years, the Mongol system worked because great fighters were great logisticians.

James Chambers
The Devil's Horsemen

Ten Important Books on Logistical History

As a basis for decisions of public policy and military action, civilian and military leaders require some background in logistics. Lack of experience can lead to unforeseen problems, losses and expense. Students of the industrial mobilization and procurement activities of World War I and II, for example, are amazed by how frequently lessons of the first were ignored in the second and the same mistakes repeated. How, then, except by actually participating in logistical operations, do policy makers and commanders get the experience? As history illustrates the need, history provides the answer.

The historiography of logistics is not extensive. The larger part of military history has tended to place full-blown armies in the field without accounting for how they got there or were supplied. Books on logistical history can be found, however. Most have been written in the last three decades, and some are very good. The following list counts two-volume sets as one book.

Cuff, Robert D. *The War Industries Board; Business-Government Relations During World War I.* Baltimore: Johns Hopkins University Press, 1973.

Goff, Richard D. *Confederate Supply.* Durham, North Carolina: Duke University Press, 1969.

Hagood, Johnson. *The Services of Supply; A Memoir of the Great War.* Boston: Houghton Mifflin, 1927.

Heiser, Joseph M. *Logistics Support.* Vietnam Studies. Washington: Department of the Army, 1974.

Huston, Dr James A. *The Sinews of War: Army Logistics, 1775-1953.* Army Historical Series. Washington: Office of the Chief of Military History (OCMH), Department of the Army, 1966.

Risch, Erna. *Supplying Washington's Army.* Washington: Center of Military History, Department of the Army, 1981.

Leighton, Richard M., and Robert W. Coakley. *The War Department; Global Logistics and Strategy, 1940-1943, Global Logistics and Strategy, 1943-1945.* US Army in Word War II. Washington: OCMH, Department of the Army, 1955, 1968.

Ruppenthal, Ronald G. *The European Theater of Operations; Logistical Support of the Armies.* 2 vols, US Army in World War II. Washington: OCMH, Department of the Army, 1953, 1959.

Smith, R. Elberton. *The War Department; The Army and Economic Mobilization.* US Army in World War II. Washington: OCMH, Department of the Army, 1959.

Van Crevald, Martin. *Supplying War; Logistics from Wallenstein to Patton.* Cambridge: Cambridge University Press, 1977.

If you read nothing else on logistical history, read Huston. *Sinews of War* traces the logistics of American armies, from the Revolution to Korea, is comprehensive and authoritative and stands as the state of the art for the field. Van Crevald's *Supplying War* provides a broader, international approach to logistical history from the 17th century through the 20th. It is a controversial work that will not evoke universal approval. The conclusions drawn in his *War of the Accountants* chapter, for example, trumpet the often-heard complaint about timid American planners after the Normandy landings. Van Crevald emphasizes the historical change in the bulk of supply from food and fodder to ammunition and fuel and the effects this change had upon movement. For that, as well as the discussion he has sparked about logistics, Van Crevald has made an important contribution.

After Huston and Van Crevald, general works on logistical history are not so comprehensive. Supplemental general readings on the field may be found in George A. Lincoln's *Economics of National Security; Managing America's Resources for Defense* (Englewood Cliffs, New Jersey: Prentice-Hall, 1954) and Henry E. Eccles' *Logistics in the National Defense* (Harrisburg, Pennsylvania: Stackpole, 1959). Lincoln's book was written with a 1950's immediacy that does not always meet more contemporary needs. But his broad strokes on resources and their management, finance, and the international implications of defense economics lend Lincoln's work continued relevance. His approach is considered especially useful by the *long war* school of mobilization planners. Admiral Eccles' book is a collection of his lectures and research papers on the subject, each discussing theoretically the history organization, coordination, planning, and programming of logistics.

There are large gaps in the bibliography of books devoted to the logistics of American armies in specific wars. Most are concentrated on World War II. Erna Risch's *Supplying Washington's Army* is a major logistical history on the American side of the Revolution. Readers interested in the other side might consult R. Bowler's *Logistics and the Failure of the British Army in America, 1775-1783* (Princeton: Princeton University Press, 1975). Goff's *Confederate Supply* examines another failure of logistics and is, aside from railroad histories, the only major work on Civil War logistics yet available.

Huston's chapters on World War I remain the best overall treatment of army logistics during that conflict. For more detailed reading on a particularly important aspect of World War I logistics, Cuff's *War Industries Board* (WIB) is an excellent scholarly examination of the problems central to industrial mobilization. Hagood's *Services of Supply* is the memoir of the title unit's chief of staff in France and is useful on the details of administering the logistics of the American Expeditionary Force (AEF). Only readers with a special interest in American logistical efforts in that war should turn to Benedict Crowell's *American Munitions, 1917-1918* (Washington: Government Printing Office, 1919). Crowell was Assistant Secretary of War and Director of Munitions, and his book, actually a government report, makes for deadening reading of facts and figures. More readable and comprehensive, but much more lengthy, is a six-volume work he wrote with Robert F. Wilson on many aspects of American mobilization, transport, and supply: *How America Went to War* (New Haven, Connecticut: Yale University Press, 1921).

Selections in logistical history are much easier for World War II, and correspondingly, less needs to be said to introduce them. The Leighton and Coakley volumes provide an overall view of the problems of allocation at the highest levels. Ruppenthal's work is the only systematic treatment of theater logistics available for the war. Pacific theater logistics are dealt with in Leighton and Coakley and in the campaign studies of the US Army in World War II series. Smith's *Army and Economic Mobilization* rounds off the World War II studies with industrial mobilization and the Army's massive procurement program.

Readers must await the publication of a comprehensive treatment of American logistical efforts during the Korean War. Until the volume on logistics in the Center of Military History's Vietnam series appears, General Heiser's *Logistics Support* provides an overview of the complex problems involved in supplying forces in Southeast Asia.

Bruce D. Hardcastle
Managing Editor
The Army Historian

Chapter One

Early American Logistics

1760-1860

The history of the US military has its roots in the changes that were beginning in the 18th century. Standing armies had come into being, the industrial revolution was introduced with mass production and interchangeable parts, modern weapons with their increased firepower were becoming standard, and a hierarchical rank structure was being established on a permanent basis. Accordingly, logistical support was also changing. The early American period addressed in this chapter encompasses the Revolutionary War, War of 1812, and Mexican War of 1846. During this time, military logistics underwent many changes, from a completely decentralized concept to a centralized one that would lay the foundation for modern logistical operations.

Prior to 1760, the entire matter of concerted defense of colonial North America had always been under the guidance and administration of England. England insisted that a unified common defense establishment be created for all the Colonies after the Seven Years War. Ironically, this contributed to the growing resentment in the Colonies, for included in this defense establishment was a projected standing army of 10,000 men to be supported and quartered by the Colonies (7:1). Because of England's attempt to impose a standing army in the Colonies and the increased levies of taxes, armed conflict soon arose between the Colonies and the Crown.

Prior to actual hostilities with England, each colony, with the exception of Pennsylvania, had established its own militia patterned after the British system. Every able-bodied free male from 16 to 60 was required to provide military service, appear for training a certain number of days each year, and be available for call in case of Indian attack or other emergency. Each Royal governor maintained his militia in accordance with his needs, and each militia was obligated to serve only within the boundaries of its own colony. There were 12 (eventually 13) individual militia units—one for each colony. Each militiaman was expected to provide his own weapon, ammunition, food, clothing, and blankets. For those who were too poor to provide these things, the local authorities maintained a small reserve of weapons, ammunition, and other goods (1:28-29). The Colonies entered the American Revolution with this decentralized militia system adopted from England.

Revolutionary War

The First Continental Congress met on 5 September 1774 to address grievances against England (1:42). The first concentrated effort to gather supplies was seen in Massachusetts, where the militia was reorganized to remove any royal taint. Minuteman units were constituted, funds were voted, stores were purchased and collected in Concord, and resolves for establishing a New England army were drawn up (7:9).

In response to the British attack at Concord on 19 April 1775 (1:42), the Second Continental Congress met on 15 June 1775 to authorize the establishment of an army and appoint George Washington commander in chief. At this time, the new nation was still a weak confederation of 13 independent states.

> Colonial tradition, divided loyalties, the nature of the economy, and spirit of revolt born in opposition to the use of military force to suppress popular liberties, all worked against the creation of any new strong central authority capable of mobilizing resources effectively for the long struggle ahead (8:44).

Thus, there were 13 individual Colonies, plus the Continental Congress, rebelling against England.

Administering the New Army

Besides appointing Washington as commander in chief of the Continental Army, Congress also set up a series of staff offices closely resembling those in the British Army, prescribed a pay scale and standard ration, and adopted articles of war to govern the military establishment (1:47). In June 1775, Congress passed legislation authorizing the Adjutant General, Commissary General of Stores and Provisions, Quartermaster General, Paymaster General, Commissary General of Musters, and Chief Engineer for the Army. In July, Congress established a *hospital* (medical department), provided for a Barrack Master, and authorized a Commissary of Artillery. By the end of 1777, the Commissary General of Military Stores, Commissary of Forage (under the Quartermaster General), Commissary of Hides, and Clothier General had been added (6:8).

Each agency worked independently, and there was no single individual or organizational head to effectively administer the various functions without executive authority. Congress was at the mercy of the various Colonies to support the Army voluntarily.

Of the various committees established to meet specific needs, the Quartermaster General was the most important. This official was charged with "supplying tents and camp equipment, transporting the army, and assisting field

commanders by planning marches, distributing march orders, laying camp sites, and assigning troop quarters" (26:18). Of these, the most important responsibility was providing for transportation. This included providing horses, pack animals and their forage, boats, and wagons as well as opening roads, building bridges, and identifying the routes that the army would follow (19:28).

The second major committee to be formed was the Commissary General of Stores and Provisions. This committee, like the Quartermaster General, reported directly to Congress, and its primary responsibility concerned feeding the troops. By 1777, Congress divided this department into two sections: the Commissary General of Purchases and the Commissary General of Issues (19:32).

Engineering Support

Aside from providing transportation and rations, Congress authorized a chief engineer in June 1775, but it was not until 1779 that the Corps of Engineers was established (15:25). James Huston described the engineering role in his important work on logistics, *The Sinews of War*:

> Broadly speaking, engineer officers performed three types of services—activities related to tactical operations, activities in support of transportation services, and construction, though in the latter two categories, they were performing essentially quartermaster functions. Support of tactical operations included the selection and layout of defensive positions and supervision of the construction of trenches and defensive positions and supervision of the construction of trenches and mines in siege operations. For the support of transportation, they reconnoitered road routes and rivers and supervised the building and maintenance of roads and bridges and the building and operation of boats. Construction work included barracks, magazines and depots, and other military facilities (6:37-38)

The most difficult task was finding personnel qualified to function as engineers. Prior to the war, all support came from England, and as a result, there was no one in the Colonies with the abilities to handle such an undertaking. Most of the engineers were found among foreign volunteers who demanded a commission of high rank. This caused friction between the foreign and colonial officers. However, because the personnel were essential, the rank was provided. The majority of the foreign engineers were from France and served the revolutionary cause well (6:12-13).

Guns and Ordnance

The procurement and distribution of weapons and ammunition was, at one time or another, by several different departments. Congress worked on the concept of creating and disbanding or changing departments as the situation required. As a result, the procurement of arms and ammunition rested with several different congressional committees. Initially, personnel were required to provide their own weapons, and Congress did not really get involved until the Board of War and Ordnance was established in June 1776 (17:20).

Later, Congress established the Commissary General of Military Stores for procuring ordnance, issuing ordnance supplies, and maintaining records of ordnance stores. Problems were compounded when artillery officers were authorized to withdraw ordnance on their own authority, thus reducing accountability. Furthermore, two additional committees, the Field Commissary of Military Stores and the Surveyor of Ordnance, were also involved. One was responsible for the distribution and care of ordnance, while the other dealt with the foundries and magazines. Neither of these committees was accountable to another nor was one committee specifically responsible for the activities of the others (6:10).

Lack of Control

With the exception of the Medical Department with responsibilities much as they are today, the above major committees were held responsible for the various logistics requirements of the Army. There was no executive authority to administer the Army's requirements. Everything was extremely decentralized, funds were lacking, and the Continental Congress had to rely upon the various Colonies for support. Congress had no power to tax or force requirements on the individual Colonies. It was not until the ratification of the Constitution in 1789 that Congress had the power and authority to raise and support armies. Until that time, requirements were met on an *as needed* basis.

Although the military system was patterned after England's, the weakness of decentralized control made it an extremely ineffective method for conducting a war effort. Washington himself was well aware of the various problems in logistics but seemed unable to do anything about them. He maintained constant contact with Congress and was reluctant to do anything without its approval. Huston emphasizes, "Indeed Congress on occasion indicated its willingness to abdicate its responsibilities altogether in favor of Washington's personal role. But he would have none of it" (6:17). Washington consistently deferred to civilian authority.

Looking at the Revolutionary War from the standpoint of supplying and supporting the troops, we can see the emergence within the United States of five basic aspects of logistics: the industrial base, requirements, acquisition, distribution, and maintenance. The basic function of the military staff that dealt with each of these areas has already been identified. But what effect did logistics have on strategy and tactics of the Revolutionary War? To begin with, the industrial base—or lack of it—was the root of many problems that impacted the conduct of the war.

Industrial Base

Logistics has frequently been classified as the *bridge* between the industrial base and the armies. At the time of the Revolution, the industrial revolution had not taken hold in the Colonies, and British rule forbade colonial trade with any nation except

(Continued on page 12)

Battle of the Bulge Logistics

Staff officers who served in the Continental Army from 1775 to 1783 were a unique breed. By 1780, people had practically forgotten that a war was still being fought, but these officers remained dedicated, patriotic, and honest. What motivated these men to join the Army, and why did they continue to serve despite economic and psychological hardship? The mere assertion that staff officers were motivated by patriotism or concern for personal honor seems questionable to us today. However, by reading the words of these officers, which were often written in private correspondence or during battles, we can gain a personal insight into why Americans participated in the Revolutionary War.

Men originally joined the staff department for different reasons—to make money, preserve their liberty, or serve their country. As the war progressed, however, *economic* incentives and the *fear of enslavement* lessened in importance, while *patriotism* and *honor* remained strong. This patriotism was also supported by a deep sense of *loyalty* to the staff departments and to other officers.

A strong motivation for joining the staff department of the Continental Army was the desire for *economic* gains. At the beginning of the war, it was common knowledge, especially among merchants and those involved in trade and commerce, that serving one's country could also be profitable. However, the question of making a profit had little influence on the decision of high-ranking staff officers to accept an office. Economic self-interest was much more evident among deputies and assistants who believed fortunes could be acquired while serving in the Quartermaster and Commissary Departments.

Once in office, however, these officers were soon without any hope of monetary reward. Added to this demoralization factor was the disorganization and related problems caused by the nation's chaotic finances (lack of money to purchase supplies, debts, lawsuits, and the loss of prestige). Even though many staff officers refused to serve under these adverse conditions and resigned, many others stayed long after they had just reason to leave.

Although these men rarely expressed a *fear of being enslaved,* when explaining why they had joined, they, along with a host of other Americans, probably joined the Continental Army believing "nothing less than a deliberate assault launched surreptitiously by plotters against liberty" had commenced with the opening of hostilities on Lexington Green (1).

The *patriotism* of staff officers was expressed in three distinct but overlapping ways: *serving their country; serving the Commander in Chief, George Washington; and preserving the Army and its reputation.*

Throughout the war, patriotism remained a strong motivator. These officers frequently used the patriotic appeal of serving one's country to encourage their men to greater effort and to settle disputes and maintain harmony between officers.

Top officials also resorted to this type of appeal to dissuade subordinates from quitting the service. On one occasion, Deputy Quartermaster Udny Hay appealed to them, "In the name of your *yet bleeding Country*" remain at your posts (2).

Amongst the ideals of this group of men, the Army shared a place of honor with serving one's country; American independence depended on the Army. If the Army were defeated, the means by which life, liberty, and property were to be defended would also be lost.

A sense of *personal responsibility to George Washington*, as well as to the Army and American independence, motivated staff officers. Their love and esteem for Washington often reveals the extraordinary reaction that this force of character and symbolic role produced. When these officers failed to live up to Washington's expectations, anxiety and guilt consumed them; to disappoint him was to fail the cause of American independence.

By far the most powerful value motivating these officers, however, was an *inner desire to preserve, defend, and add luster to their reputation and the honor of their respective departments.* Without a good reputation, a man could not seek a public office or a place of influence in the community, and he could not maintain commercial connections for very long. For Nathanael Greene and other staff officers, to preserve and add to their reputation typified their highest aspiration in the war. Also, the reputation of individuals could not be separated from the reputation of the department. The desire to bring honor to the department inspired these men to perform conscientiously and comply with orders and regulations. If they did not, they were rebuked by others for disgracing the department.

A strong sense of *loyalty* toward one another also emerged among these officers during the hardest days of the war. The day-to-day routine—supplying the Army and caring for its sick and wounded—provided them with a common goal, and success rested upon their cooperation, energy, and dedication. From these occurrences, often strengthened by crisis, arose a respect for each other. Superiors praised them for their accomplishments, which in turn established a special rapport between the superior and the subordinate.

> For one rare moment in American history, among at least one group of men, self-interest was not at war with the common good; instead serving the public promoted and enhanced the self. By steadfastly doing their duty—purchasing food, transporting camp equipment and tending the sick and wounded—staff officers brought honor to themselves, to the staff departments, and in retrospect, to the cause of American independence (3).

These values—patriotism, loyalty, and most of all, honor and reputation—provide the key to understanding the willingness of staff officers to undergo the hardship and strain of public service.

Notes

1. Bailyn, Bernard. *Ideological Origins,* 95.
2. Udny Hay to the Asst Deputy Quartermaster, 6 October 1779, Nathanael Greene Papers, APS.
3. Carp, E. Wayne. *To Starve the Army at Pleasure: Continental Army Administration and American Political Culture, 1775-1783*, University of North Carolina.

E. Wayne Carp
Condensed from Chapter 6, "Motivation of Staff Officers," *To Starve the Army at Pleasure: Continental Army Administration and American Political Culture, 1775-1783*, University of North Carolina Press, *Air Force Journal of Logistics*
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Greene's Strategy in the Southern Campaign, 1780-1781

Nathanael Greene was one of the true heroes of the War for Independence: first, as a 33-year-old major general; later as Washington's Quartermaster General; and finally, as Commander of the Army of the South. Of all our Revolutionary War leaders, he keenly understood the relationship between logistics and success on the battlefield.

Nathanael Greene was operating with an army that was basically infantry. This force was capable of some rather extended marches, but the average daily distance was about 12.75 miles. This distance reflected the settlement pattern of the region since the army usually marched from early morning to about noon and then camped. Other extenuating factors included the poor roads and the lack of adequate transport to carry equipment and provisions. In an extreme case, the army was capable of marching more than 30 miles at a time, but this distance would require a longer resting period.

The army camped in close proximity to mills virtually every night, although some were remote from the army. Since the army spread out at least 1 mile as it marched, the headquarters and a portion of the army might be at the mill itself, while other units might be quite some distance off.

In addition to the normal reasons for camping at mills—open space, water, and grain—they indicated the extent to which Greene exploited the totality of the regions through which he marched. Mills are often associated with the country-level command structure through the militia ranks given mill owners. A great many of the mills were owned, if not operated, by members of the local elite who could be identified by their high militia rank. Thus, Greene, acting as the military commander, required the local leadership, the elite of the county, to produce those supplies that his army needed simply by operating within the chain of command. In effect, Greene mobilized an already existing political-military structure to meet the short- and long-term requirements of his soldiery. Doing this enhanced the stability of the patriot political system and also identified those who were not supportive of the cause.

It is axiomatic that any army travels on its stomach. Greene's troops were no different, but their fare was lean indeed. On many occasions, they went without food, and their rations rarely came close to matching those stipulated by the regulations. Greene's effort to procure foodstuffs for his army reached monumental proportion, and further study of his letters to determine precisely what percentage dealt with food would be illuminating. Greene's strategic use of the piedmont to feed his men can be illustrated by two isolated but typical examples.

The first episode begins with a letter that details how the militia forces operating around the Moravian (North Carolina) settlements in early 1781 gathered supplies for the army. Although the Moravian villages were somewhat north of the line of march for both the *flying army* and the main army, Greene's commissary troops were gathering supplies in advance of them, which could then be ground at mills in the vicinity of Guilford Courthouse. In addition, sweeping up flour could speed issuing, while gathering grain could impede the British by causing them delays in gathering and processing food. It is a particularly succinct commentary on the supply situation and the fluid nature of the campaign that I have yet to identify a single instance of mill destruction by either side. Even though Greene did not specify that all materials were to be removed by foraging parties during February 1781, it is clear this kind of operation was underway, and Greene certainly ordered the total removal of supplies ahead of the British in March 1781.

When Greene marched his army back into South Carolina in April 1781, he moved slowly enough so supplies could be placed in mills ahead of the line of march. To ensure foodstuffs on the march, he issued orders to the country colonels, telling them to bring grain to central locations. This can be seen in letters to Greene written by Colonel Thomas Wade. Wade was writing from Haley's Ferry, a day's march ahead of the main army, which was then at Kimborough's Mill on Little River. Three days later, the army was at May's Mill where the provisions were apparently not sufficient since the army stayed only 1 night.

The importance of prepositioning supplies cannot be overestimated. It was necessary to rest the horses, if not the men, at 5-7 day intervals. An overnight stay turned into being onsite for 2 days. Two days would virtually exhaust an area of supplies if they had not already been augmented by collection prior to the army's arrival. Greene clearly understood this, and he ordered Polk to maintain a 3-day supply of provisions at magazines within 2 weeks of his arrival at Charlotte in December 1780. Since the vast majority of the camps were of 1 night's duration, a 3-night camp involved a great deal of effort to ensure that adequate food would be on hand. Only 15 camps lasted for more than 3 nights, while only 18 camps were 2 to 3 nights' duration. The analysis of camp duration suggests that the army moved in accordance with the presence of supplies gathered ahead of it, as much as in response to the availability of supplies at its current location or enemy movements.

At no time did the army issue more than 3 days' rations to the men in the Southern *campaign*. This is because the men would have had to carry the provisions and the added weight would have been dealt with by consuming it immediately, especially because of available short rations. Yet the requirement for 3 days' rations, which is repeated on numerous occasions, has antecedents related to infantry marching and carrying rates which were as true in Alexander the Great's time as in Greene's time. It was simply impossible for any army to carry more than 3 days' rations.

As a result of Greene's experiences in the North and the situation in the South, he became his own quartermaster general while also directing the army in maneuvers against the British. As he traveled south in October and November 1780, Greene had called on Congress and the state legislatures to provide the needed supplies. These were easily promised, but actually obtaining them proved far more difficult. Nevertheless, the long-range planning instituted by Greene from the start of his journey was to pay dividends in the early summer of 1781. The clothing that reached Greene's army at Ninety-Six provides an excellent opportunity for understanding Greene's logistics sense as it related to uniforming his command.

Only a single example of uniform transportation and issuing will be presented. There are others that amplify the situation as well as illuminate Greene's thoughts on uniforms and how they were procured. Despite the scattered nature of the sources, it has

been possible to trace the movement of three different clothing issues from the point of origin to the place of issue. The supply convoy first appears in the records as originating in Philadelphia, although it seems as if a portion of the clothing came from Newburgh, New York. The letter to Greene mentions that 25 wagons had set out from Philadelphia for the Southern Army. It is clear from other documents that the convoy did not leave Philadelphia until at least 29 March because the invoices of supplies are dated then. The invoices note the quantity of materiel in each box and give box numbers, so it is possible to trace these items rather easily.

The wagon train is mentioned in another letter, dated 5 April, stating that it was being conveyed under the direction of Barney Hart. Again, this letter to Greene originated in Philadelphia. By the end of April, the convoy had reached Carter's Ferry, Virginia, but now had only 24 wagons and was without guards. By 17 May, the group had reached Salisbury, North Carolina, and numbered only 22 wagons, giving some testimony to the attrition that occurred to overland transportation.

On 21 May, Greene sent Major Lewis Morris, an aide, to bring the convoy on from Salisbury. This is important to note because Greene was about to commence siege operations at Ninety Six, yet he was more concerned with outfitting his troops than documenting the siege. Morris was at Charlotte by the 24th and ordered the brigade of wagons and the troops from Salisbury to the army. The directions are quire explicit as each stopping place and river crossing is cited. On 1 June, the supplies had apparently reached the army because a return of clothing wanted was made at Ninety Six. The Clothier General for Maryland reports the clothing was issued on 10 June, so it is apparent that the uniforms were reaching the troops in the field some 70 days after leaving Philadelphia.

Any person who studies the returns, invoices, and issuing receipts will note that the invoices contain few references to overalls, although many were issued. The halt at Salisbury explains this because Salisbury, now a major producer of clothing, was also a center of shirt and overall production for Greene's army in 1781. The layover of the wagon train would have allowed the time to load overalls missing from the Philadelphia invoice. These overalls and shirts were available in May 1781, because the countryside around Salisbury had been producing them since December 1780 per Greene's instructions.

In this example, it is clear that Greene's planning involved the total resources of the area he was defending. The people had been asked to provide supplements long before the actual need was present. This is not readily apparent until inspection of supply movements, together with invoices, identifies what was brought from the north and what was actually issued. Once the documents are examined in this fashion, it is certain that the Southern Army would have been without overalls had Greene lacked the foresight to order them made locally some 6 months before they were issued.

In order to supply his men with arms and ammunition, Greene started one laboratory at Salisbury, North Carolina, and a second in Virginia. Both of these operations continued to supply the army with materiel, but they had constant problems. Again, the major difficulty may have been transport and its susceptibility to weather, as cartridges were often reported useless when wet.

Munitions were also brought overland from the north. Among the 22 wagons that finally reached Salisbury in May 1781, ten contained ammunition. Included in this total at the start of the journey south were nearly 100,000 musket cartridges and assorted shot for the artillery. Because of the amount of materiel damaged in transit, the production of ammunition at local laboratories was a necessity if Greene's troops were to continue the struggle. Again, the long-range planning instituted by Greene in December 1780 and January 1781 was crucial to his army's ability to fight in May, June, and July when the British were driven into coastal South Carolina.

The constant problem with transportation, which permeates Greene's correspondence, was dealt with by trying to convert wagon convoys to pack trains. This response to the crude road network and the sorry state of equipment was taken prior to March 1781, but it never rid the army of its transport woes, *since* wagons were still used and the roads were not improved.

Perhaps the most revealing aspect of Greene's strategic sense can be seen in his movement of troops around the piedmont. The number of days spent in any one camp has already been mentioned, but a closer look is necessary. The supplies of food at a camp would be depleted rather rapidly with the arrival of the army. Consequently, Greene ordered that magazines be established that could contain 3 days' food supply so the army could rest at least 1 day and still have sustenance to march to another supply point without food.

Of the 133 camps between 1 June 1780 and 30 August 1781, only 42—or 31.5 percent—were more than 1 night. Even then, only 15—or 11 percent— were more than 5 nights. The poor roads and transport, coupled with the area's ability to provide food, were reflected in camp duration. Greene's planning coped with the supply problem by storing supplies ahead of the army on the march, but the difficulty grew worse with a longer stay in camp. At the longer camps, Greene resorted to another method of supplying his men. This different approach involved the river system of the piedmont. Greene's application of rivers to supply his men provides a clue to his using the piedmont in purely military terms because it is the key to understanding his strategy during the campaign.

In conjunction with Greene's placement of long-term camps and troop movement, he made a major strategic decision in December 1780. He sent Daniel Morgan and a *flying army* to the west while he moved the main force to the Peedee River just below the North Carolina border. The division of forces might be seen as violating the principle of mass, but Greene was using economy of force to achieve a portion of his strategy by breaking "down the enemy's control while simultaneously preventing him from interfering with" the main army.

In the main camp at Hick's Creek on the Peedee River, Greene busied his army in many ways as the militia continued to provide supplies. The transport of those supplies had changed somewhat because there were calls in the orders for boatmen to bring in the foodstuffs. Greene was simply using water transport, in addition to wagons, in his effort to supply the army. At the same time, boats were constructed with wheels to enable them to move with the army so stream crossing would be possible. Both water-related activities reflect Greene's strategic sense of the river system in piedmont Carolina.

While at Hick's Creek, Greene also authorized a raid on Georgetown, South Carolina, which was to be, in part, an assault by troops who would float down the Peedee River and land at the town docks. Again, knowledge of the river system enabled the

tactical attack to be done. In a tactical sense, this little known attack on Georgetown—to the east of the main British outposts at Camden, Winnsboro, and Ninety Six—might have shifted British attention away from Morgan's small force operating on the headwaters of the Broad River. It certainly tends to confirm the statement that Greene understood the river better than those who had grown up in the vicinity of the Catawba, another river Greene used during his campaign.

Greene's strategy in dividing his forces thus becomes a little clearer. Dividing his forces provided them with a better opportunity to obtain supplies and disrupted British attempts to forage in the same area. By controlling the headwaters of drainage systems from which the British were deriving their sustenance, Morgan, Greene, and their partisans intercepted the supplies at their source. The British do not adequately report that they were using watercraft to provide transport for supplies, but some references can be found to that effect. If the British were supplying their outlying garrisons with waterborne food, then those supplies had to be moved upstream, against the currents in storm swollen rivers, after Morgan and Greene moved to their positions in December 1780, because they effectively cut all rivers about the garrisons.

Another example of strategic use of rivers can be deduced for the period after Morgan's defeat of Tarleton and Cowpens on 17 January 1781. Greene made a rapid withdrawal to Virginia, which broke the back of the British supply system. For one thing, Cornwallis destroyed his wagon train to lighten his troops for the pursuit. Yet Cornwallis was to pursue Greene into an area from which Greene was withdrawing. As Greene retreated, he brought all the boats to his river crossings and then removed them after the American troops passed. In addition, the militia were used to sweep the area ahead of the armies for food supplies, thereby denying both supplies and the means of transporting them to the pursuing British.

Only when Greene crossed into Virginia and found himself downstream from Cornwallis did he turn and commence the maneuvering that led to the battle at Guilford Courthouse. In light of his earlier interdiction of supplies going to the British along drainage systems, Greene's turning to fight can possibly be explained as necessary. The Southern Army had moved onto a river system that led to another British Army located downstream. If it remained on the river, Cornwallis would be upstream and able to interdict any supplies moving along the river.

As it worked out, Greene had already overextended the British. Cornwallis turned and entered Hillsborough, North Carolina, in an effort to recruit and resupply troops. During the *race to the Dan*, Greene had used defensive tactics that forced the British to pursue in such a fashion and to such a degree that, even though Greene was forced to retreat, he still retained control of his actions and avoided disintegration of the army while breaking down the British ability to wage war.

For the same reasons, Greene did not follow Cornwallis to coastal North Carolina after Guilford Courthouse. Since it was possible to obtain supplies from upstream, the area had been so thoroughly covered by both armies that the Americans were fainting from the lack of food just when they commenced their pursuit. Unwilling to risk another period of starvation, Greene turned into an area that had provided him with food during the stay on Hick's Creek in December and January.

Greene's return to South Carolina shows again the superb strategic sense he possessed. He began to conduct a harassing campaign against scattered British garrisons. The weaker ones were attacked and taken, and the stronger ones were subjected to a campaign of supply interdiction, which eventually caused their abandonment. Greene used the same procedure that had proven successful in January. He had partisan raiders intercept both wagon- and boat-carried supplies heading for the British, while he made the situation intolerable by threatening the garrisons with military forces as well.

The interdiction of supplies continued even after the British abandoned the piedmont to the rebels in the summer of 1781. Confined to a narrow coastal strip running from north of Charleston to south of Savannah, the British were faced with the choice of abandoning the southern states or starving to death. Greene had cut off the coastal area from the hinterland and its supplies upon which the British depended.

Greene acted throughout the Southern campaign as if he were still the quartermaster general who had restored order to the supplying of the Continental Army. He obtained supplies while denying them to the British. It was almost as if he put himself in the place of the British quartermaster's office and designed the worst possible scenario for the British. When doing so, he utilized the resources of the piedmont in a massive effort to maintain his own forces. This application of the political, social, economic, and military resources of the Carolinas gave him a victory. His use of the resources was far more than simply maneuvering his army through a series of battles, because his strategic objective was to maintain his army in the field no matter what happened. Even though Greene suffered from bad luck and conservative judgment in tactical situations on the battlefield, he was successful, despite never winning any battles, because his *comprehensive direction of power* broke the British. In this sense, his manipulation of the resources in order to obtain supplies required for his military strength has to be seen as the major strategic effort of the Southern *campaign*, which won the South for the United States.

At its most basic level, Greene's strategy can be seen in the maintenance of the Southern Army. His performance and that of Washington in the early war years probably did more for winning the Revolution than any other two campaigns. By maintaining a military presence, Greene continuously demonstrated that the Revolution was still in effect in the South. The British could defeat his army, but they could not destroy it. Greene's battered continentals served as a flickering beacon of revolution in the South during 1780 and 1781. In the end, Greene's strategy of mobilizing the entire Carolina countryside to support his Maryland, Delaware, and Virginia regulars proved to be the key to winning the South once and for all.

Dr Lawrence E. Babits
"Greene's Strategy in the Southern Campaign, 1780-1781" Air Force Journal of Logistics
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England. Furthermore, England did not provide an environment for the Colonies to establish their own manufacturing capability. Thus, manufacturing was practically nonexistent. This lack of manufacturing and processing facilities prevented the proper equipping and supplying of the Continental Army throughout the war's duration (26:19). Therefore, most essential military supplies had to be imported. Characteristically, though:

> . . . the expanding demands for the army provided impetus to manufacturing, particularly for the fabrication of cloths of all kinds—duck, Russian sheeting, tow cloth, osnaburg, ticklenburg—and to the production of shoes, gunpowder, and small arms (7:21).

The Continental Congress did, however, establish public arms factories and armories in order to produce firearms, gunpowder, and artillery pieces. Although the industry was small and the work was accomplished in small shops, it was the genesis of the modern military-industrial complex. Then, m as today, the government provided the funds to subsidize the industry. For example, the Connecticut Committee of Safety spent 1,450 pounds to fit a furnace at Salisbury for casting cannon and shot. Employing 59 men, this plant turned out guns ranging in caliber from 4- to 32-pounders (6:23).

By and large though, the Colonies were unable to produce or manufacture the needed war materiel required to support the army and its drive for independence. Without extensive support from France in financial aid, supplies, and troops, it is unlikely that the war would have been concluded in victory.

A Matter of Buttons, 1778

One incident in particular epitomized the senselessness of it all. General Anthony Wayne, famous for his daring leadership in battle, tried to make arrangements to get 500 coats for the ill-clad men under his command. The Clothier General, James Mease, a congressional appointee, insisted that only authorized civilian tailors could do the work. While Wayne's troops continued to suffer, Mease took a leave of absence, and there was no one who could process the order. When he returned to duty, the Clothier General refused to issue the uniforms because only yellow buttons were available and Pennsylvania's regimental design specified white buttons. Finally, an apoplectic Wayne had the specifications changed, and Mease released the coats. How many of Wayne's soldiers died from exposure while this farce was playing itself out has never been determined.

James Kirby Martin
Mark Edward Lender
A Respectable Army: The Military Origins of the Republic, 1763-1789

Requirements

The process of determining actual needs of the Continental Army echoed the problems seen in other areas of logistics. The system was extremely decentralized, and committees were established to handle problems as they arose. The Colonies never seemed to have sufficient military supplies for their forces. As early as October 1774, the Provincial Congress (sitting at Cambridge) chose a committee of safety with power to collect military stores and "if necessary to summon and support the militia" (2:7). In April 1775, the Provincial Congress decided an army was necessary, and the individual Colonies should provide the necessary men and supplies. Requirements were slow to be established, and it was not until June 1775 that the Continental Congress voted to establish the Continental Army. Congress' initial act was to establish a requirement for ten companies of riflemen (1:46). In September 1775, the requirement was raised to 26 infantry regiments of 728 men each, along with a regiment of riflemen and artillery. This equated to a total force of 20,372 men.

However, the plan was never fulfilled, and by 1 January 1776, Washington had only 8,000 men versus the 20,000 planned (1:49).

Short-term enlistment was also a problem that would plague Washington throughout the war, one that caused the size of the army to vary at any point in time. Failure to establish a long-term enlistment arrangement also dictated when battles would be fought. For example, the Battle of Trenton was fought on 26 December 1776 so Washington could use his forces before their enlistment expired on 31 December. The Battle of Princeton was fought on 3 January, but this was possible only after Washington offered a $10 bounty to his men to remain with him for another 6 weeks (1:67-68). Congress attempted to establish a 3-year enlistment and a requirement for 110 battalions of infantry (about 75,000 men), but neither materialized.

Rarely did Washington ever have more than 15,000 men at any one time. Recognizing this problem, Congress recommended that a draft be established. "This first American wartime draft was applied irregularly in the various states and succeeded no better than had earlier methods in filling the Continental ranks" (1:56).

In other areas, Congress did establish rather specific requirements:

> For rations, specifically, they resolved, that a ration consist of the following kind and quantity of provisions: 1 lb beef or 3/4 lb pork or 1 lb salt fish per day; 1 lb bread or flour per day; 3 pints of peas or beans per week or vegetable equivalent, at one dollar per bushel for peas or beans; 1 pint of milk, per man, per day or at a rate of 1/72 of a dollar; 1 half pint of rice, or 1 pint of Indian meal, per man per week; 1 quart of spruce beer or cider per man per day or 9 gallons of molasses, per company of 100 men per week; 3 lbs candles to 100 men per week, for guards; 24 lbs soft or 8 lbs hard soap, per 100 men per week (16:25).

Requirements for other supplies—such as tents, clothing, cooking utensils, and so forth—went along the same lines.

Logistical Savvy Turns the Tide

American artillery prepares to sweep the streets of Trenton. Note grapeshot being pulled from the ammunition chest in the foreground.

After initial success in driving Howe from Boston and occupying New York City, the fall of 1776 was looking very dim for the Continentals. A series of defeats made disaster for the Americans seem imminent. Washington was leading less than 3,000 poorly equipped men on a retreat through New Jersey, pursued by a British force of 6,000-7,000 well-equipped and spirited regulars.

But Howe and Cornwallis hesitated in their pursuit. Apparently, these European-trained generals were reflecting the view that winter occupation of enemy territory and logistics resources was tantamount to physically defeating him. The trouble was the Americans didn't know that! This hesitation provided Washington the breathing room to make an ingenious and now famous decision to increase his opponent's *logistical friction*. After crossing the Delaware in retreat, he instructed General Maxwell to destroy all boats except a few to be hidden for a later return crossing.

Somewhat to Washington's amazement, when Cornwallis reached the Delaware on 9 December, he was unable to cross for lack of boats. I say amazement because Washington had fully expected Cornwallis would anticipate this and make alternate crossing plans! But Cornwallis didn't. Washington had used logistics to his advantage, while the British had failed to anticipate logistical needs—a decisive and deadly combination that allowed Washington to stall the British pursuit, recross the river on Christmas Eve *in the boats saved for him,* and recapture the bulk of New Jersey.

No less important was logistics to the decisive battle of Yorktown, for which Washington employed borrowed French boats to move his troops from New York to Virginia in time to put the town under siege. This logistical feat not only allowed the timely converging of power on Yorktown but also beat the enemy by denying supplies by sea and land, forcing surrender for want of logistics support.

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Permanent magazines were established for foodstuffs, ordnance, clothing, and shoes. However, procuring these items was another problem altogether.

Acquisition

Difficulties in supplying the army were due as much to the "inability of the government to mobilize the available resources through an efficient system of procurement and supply" as to exhausted resources in the Colonies (21:16). Not surprisingly, the government's ability to obtain supplies depended to no small extent on its ability to pay. Unfortunately, because of the autonomy of the Colonies, no central authority existed to establish sound banking, financial, or monetary policies. Each Colony followed policies suited to its own needs without regard for the effects on the war economy (26:19). As a result, Congress, at the onset of the war, started issuing paper money and negotiating both foreign and domestic loans. The individual Colonies followed a similar policy. It was not long before rampant inflation was overtaking and destroying the monetary system.

Primarily a result of the lack of adequate funds, procurement or acquisition of various supplies changed dramatically throughout the war. Initially, troops were required to provide their own weapons, ammunition, food, and clothing. But for a war of any length, such as the Revolutionary War, the individual could not be expected to provide all his needs. Thus, Congress pursued a system to purchase the required goods. Inflation resulted as merchants speculated and enterprising individuals tried to get the most for those goods. With inflation running wild, the monetary system failed. Congress tried to obtain supplies through a quota system; however, it, too, failed as the states were reluctant to tax their people and hesitant to collect the quotas demanded of them. Fortunately, Robert Morris took office as Superintendent of Finance in 1781. Through his own personal loan guarantees and aid from France, Morris was able to establish a private contracting system based upon open and competitive trade in order to meet the army's needs (18:31). This basic system is still used extensively today. Aside from the financial difficulties caused by a nonexistent tax base, procurement or acquisition of supplies was a problem within itself.

Initial procurement was based on the concept of a short war. Neither Washington nor the Continental Congress expected the war to last as long as it did. At the onset of the war, the Colonies were an agricultural society with little established manufacturing. Manufactured goods were imported from Europe in exchange for agricultural surplus, and as a result, few of the items needed for a long war were available. Prior to the outbreak of hostilities, the British had provided such things as artillery, gunpowder, and military specialties for defense of the Colonies. "Concerning weapons, British legislation in 1744 prohibited the export of firearms to the Colonies" (15:56). As a result, the manufacture of arms was initiated at the start of the war; however, the majority of arms and ammunition had to be imported. Within the Colonies, two public arms factories were established—one in

Massachusetts and the other in Virginia—and 200 gunsmiths were contracted for the production of arms. An armory was also established at Philadelphia (15:26).

Captured and Imported Weaponry

In order to avoid British interception, most of the arms and gunpowder came to the Colonies by way of the West Indies in Dutch and French ships. French ships alone provided more than 100,000 muskets to the Colonies. Other means of procurement included capture of British supplies (15:26). For example, in 1775, the capture of one British ship "supplied the Continental Army with 2,000 muskets, 100,000 flints, 30 tons of musket shot, 30,000 round shot, 11 mortar beds, and a 13-inch brass mortar" (15:26). And later:

> . . . the capture of Fort Ticonderoga and adjacent outposts provided the Americans with about 78 serviceable guns ranging from 4- to 21-pounders, six mortars, three howitzers, thousands of cannon balls, nine tons of musket balls, 30,000 flints, and large quantities of related apparatus (24:47).

Obtaining gunpowder was also a problem. Stocks were low and obsolete from the start:

> In 1775, the greater part of the powder stored in the colonial magazine had laid there since the Seven Years' War. The few existing powder mills were in ruins, the manufacture of the explosive was almost a lost art, and the country was nearly destitute of ammunition and other warlike stores (28:271).

At the onset of the war, some 80,000 pounds of powder had been captured by the colonists between December 1774 and July 1775 from numerous British strongholds in New England, Pennsylvania, Maryland, Virginia, North and South Carolina, and Georgia (28:272-273). However, as early as the third of August, there was:

> . . . not enough powder in the whole army to furnish half a pound to each man exclusive of what was held in the horns and cartridge-boxes. By the last of the month, Washington's supply was nearly gone, and he had none with which to employ his artillery (28:273).

In recognition of this problem, Congress attempted to get the Colonies to start the manufacture of saltpeter and gunpowder. The Colonies were able to manufacture 115,000 pounds; however, more than 90 percent of the gunpowder and saltpeter required was imported for a total of 2,347,455 pounds (28:277).

Acquisition of lead was another problem. Lead for the campaign of 1776 "was taken from the Statue of King George on the Bowling Green and from housetops of New York," and the amount needed for the operations of 1777 came from "leaden spouts and window weights of Philadelphia" (2:115).

Personal Items and Food

Acquisition of clothing and equipment for the individual soldier went through a variety of changes during the war. However, this was to be a continuous problem resulting in the army's never having adequate clothing or equipment. To quote a letter written from Ticonderoga on 4 December 1776:

> For all the army at this place, which did consist of twelve or thirteen thousand men, sick and well, no more than 900 pair of shoes have been sent. One third at least of the poor wretches is now barefoot and in this condition obliged to do duty (2:51).

Initially, Congress followed the British example and directed that clothing be purchased and sold to the soldiers. A committee was appointed to handle the purchase of clothing and worked under the Quartermaster General. However, this system failed to meet demand, and in the fall of 1776, Congress established the Commissary of Clothing for the various field armies. This method was centralized under the urging of Washington in February 1777 with the appointment of the Clothing General. Shoes, another necessity, were handled by the Commissary of Hides that exchanged rawhides for footwear. Congress established a quota system whereby each state was directed to provide clothing and shoes. This worked somewhat better; however, by that summer, 20 percent of the soldiers were still without shoes. By March 1779, primary reliance for clothing and shoes was based on contract with France. Procurement was made by both the Congress and the individual states; however, they looked to each other to take the initiative, and the troops continued to be lacking. It was not until 1781 that an efficient administrator for the Clothing General was appointed. Under this administrator, John Moyan, contracts were established with France such that by the end of the war, the army was better supplied than at any other time (14:30-32).

Procurement of food was perhaps the most critical problem of the war and one that is difficult to understand, since agriculture was the main export for the Colonies. There never seemed to be enough food for the soldiers, and it was not at all unusual for the army to be without food for 3 or 4 days at a time or to be on one-half or one-quarter rations for weeks at a time. On the same day that Congress appointed George Washington as commander in chief, it also established the office of Commissary General of Stores and Provisions. This office was able to provide the necessary rations as long as the army stayed in New England where the main supply of food was located and the local populace was cooperative. However, once the army started moving south, the task became more difficult. Vegetables were seldom provided, and even flour and beef were difficult to obtain. As the army moved south in 1776, it increased in size from approximately 9,000 men to 19,000. Since the army was no longer stationary, permanent magazines could not be used, overland transportation was difficult at best, and wagons and horses were scarce. In the spring of 1777, an attempt was made to reduce the problem and provide for better administration by splitting the department into the Commissary General for Purchases and the Commissary General for Issue (16:26-27). By autumn, a combination of this reorganization, resignation of the Commissary General, and "ordinary difficulties like the lack

Tenuous Supply Pipeline

Under the stimulus of the war, the public and private arms industry expanded production. In the winter of 1775-1776, the arms makers of Pennsylvania, a center of the industry, alone turned out more than 4,000 muskets. The production of artillery posed greater problems, but by 1775, the foundries in Philadelphia, Springfield, and other places were casting both bronze and iron guns that were almost as good as European pieces. Enough of these were made during the war to satisfy most of the requirements of the armies, and because of imports from France, American forces did not suffer serious shortages of guns. In another area of military procurement, the Americans began and remained dependent upon foreign supplies. Relatively little gunpowder was manufactured in the Colonies, largely due to a lack of saltpeter, and Congress and the states were unable to increase production. More than 90 percent of the gunpowder used in the war was imported.

The supply function of Congress did not cease when it created money to pay for the supplies or stimulated industries to produce them. They then had to be collected and distributed to the armies, and this would have to be done by a military staff. Congress knew about the use of military staffs in European armies and, in 1775, established its own. It authorized a number of offices and appointed the holders of them, an adjutant general, to handle records, a paymaster general to disburse money, and others. Two of these officials were concerned with supply and constituted what in later armies would be called the Services of Supply—a commissary general, who purchased and issued provisions, and a quartermaster general, who supervised the transportation of them to the armies. Later, Congress appointed a clothier general, who received all clothing purchased by the Board of War. The various staff and supply officers were responsible to the Board of War, but the latter exercised only a loose coordination over them.

This failure to provide unitary direction reflected Congress' disinterest in efficient administration. The attitude was particularly apparent in its regulation of the supply services and particularly calamitous. Thus, at one time, it became disturbed that the commissary general's department was not procuring needed provisions. The solution was to split the office into two parts, a commissary general of purchases and a commissary general of issues. The apparent reasoning was that if the job was too big for one man it should be given to two; the result, of course, was to divide authority still further.

The administrative indecision of Congress was one reason that shortages of certain supplies—particularly food, clothing, and shoes—appeared in the armies as early as 1776 and continued and grew worse every year thereafter.

The suffering of the troops was not entirely due to administrative laxity. The goods in short supply were usually available in the country, but they could not be gotten to the armies. In part, the problem was transportation. Just as the British had trouble in supplying their forces if they moved away from the rivers, so did the Americans. There were few good roads, and wagons were scarce. But the root cause of the problem was the continental currency. As it depreciated steadily in value, producers tried to avoid taking it; many farmers preferred to sell to the British in return for specie. Congress was at last driven to recognizing the collapse of its currency system and the crisis of its supply system. Late in 1779, it authorized a requisition of *specific supplies* on the states. Quotas of various provisions—meat, flour, and other items—were assigned according to their resources. The states were expected to fill the quotas by assessing taxes in kind on their citizens. Barter was being substituted for currency.

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of funds, mismanagement and graft" had put the Commissary Department in worse shape (3:58).

The result was near starvation for the soldiers camped at Valley Forge that winter. At one point in December 1777, Washington wrote to Congress:

> I am now convinced, beyond a doubt, that unless some great and capital change suddenly takes place, this army must inevitably starve, dissolve, or disperse in order to obtain subsistence in the best manner possible (3:59).

In the spring of 1778, Congress again reorganized the Commissary Department. It still retained the separation of Issues and Purchases but finally allowed the Commissary of Purchase to choose his own subordinates, a task previously done by Congress. This seemed to resolve some problems, and the following winter (1778) was endured with significantly less hardship (19:32). However, the winter of 1779-80 proved to be a particularly bad one for the soldiers:

> The continental currency had virtually depreciated out of existence, and Congress was impotent to pay the soldiers or to purchase supplies. At Morristown, New Jersey, in the winter of 1779, the army suffered worse hardships than at Valley Forge. Congress could do little but attempt to shift responsibilities onto the states, giving each the task of providing clothing for its own troops and furnishing certain quotas of specific supplies for the entire army (1:88).

However, this system was also to fail as the states could never be depended upon to fulfill their requirements. Even those supplies that were acquired could not be delivered because there were no funds to pay for their transportation. Finally, in 1781, Robert Morris established a system whereby private vendors were contracted to procure, deliver, and issue the necessary rations when and where they were needed (16:28).

A Critical 16 Miles

Burgoyne's surrender of his 5,763 officers and men at Saratoga is usually held to mark the turning point of the American Revolution, for it unquestionably advanced the French alliance, if it did not actually bring about that result. The idea behind the campaign has often been criticized, and it has been contended, with some reason, that had the same amount of energy been added to the campaign against Washington in New Jersey and Pennsylvania the Americans could hardly have stood against it.

Whether or not his contention is sound is not for the present volume to attempt to determine. It is enough to say here that whatever additional errors may be imputed to General Burgoyne and to the plan on which the campaign was based, the British defeat can be traced primarily to the inadequacy of their transport system. Nor did it fail by very much. Adequate, apparently, to all the other demands of the invasion, it failed—and the expedition failed—because of the difficulties that lay in the 50-mile section of the supply line between Fort Ticonderoga on Lake Champlain and Fort Edward on the Hudson. More specifically, it was on the 16-mile *carrying-place* between Lake George and the Hudson that it most seriously failed, thus ultimately necessitating the surrender at Saratoga.

The independence of the United States, in other words, can be traced in no small part to the inadequacy of Burgoyne's transport on 16 miles of muddy, hilly road that once ran through the forest between the southern end of Lake George and the Hudson River at Fort Edward.

Hawthorne Daniel
For Want of a Nail

Hauling guns by oxteam from Fort Ticonderoga for the siege of Boston.

Evolving Acquisition Concepts

As the war progressed, the acquisition of supplies went through several changes. Initially, individual committees handled a particular item, and the system was extremely decentralized. As problems arose, Congress would reorganize whatever department handled the shortage at the time. From there, a quota system based on barter was used, and finally, Morris established a contract system. It was the contract system that finally resolved supply difficulties for the duration of the war. Distribution problems, however, were never to be resolved.

Distribution

The Quartermaster General was basically responsible for the distribution of troops and supplies. Almost everything required to support the war effort revolved around distribution. Rations, weapons, ammunition, clothing, forage, medicine, tents, and so forth had to be farmed out to the troops.

Port and coastal waterways were primarily controlled by the British and thus unavailable. The majority of the campaigns ran north-south, while inland rivers and waterways, along with what few roads there were, generally ran east-west. Problems were compounded by the slow pace of oxen teams and pilferage of supplies. Much of the transportation was provided through the contract system of hiring teams and drivers. When money ran out, impressment of teams and wagons was used. However, impressment was used only when all else failed as it often alienated popular support.

Frequently, drivers were unreliable; they would unload their wagons or deliver the supplies elsewhere either because they were not paid as expected or because they had received a more lucrative offer from someone else. To correct this problem, the Quartermaster General set up a system whereby drivers were held responsible through a bill of lading system. When sufficient drivers could not be hired, soldiers were used; however, this frequently proved unsatisfactory, as soldiers failed to properly care for the teams. As a result, the Continental Army was generally dependent upon hired or impressed wagons and teams (20:24-25).

The Canadian Campaign

The impact of distribution can be readily seen in the Canadian campaign. At the onset of the war, the major military campaign was directed toward Canada. A two-prong attack was planned with Brigadier General Richard Montgomery to take Montreal and Colonel Benedict Arnold to take Quebec. Montgomery was successful and captured Montreal on 13 November 1775. However, Arnold failed to take Quebec. During his march, he lost almost half his forces by starvation, disease, drowning, or desertion. Although almost 8,000 men were sent to Canada, the supply lines were never adequate to support the forces. As a result, by June 1776, the British had driven the American forces out of Canada (1:51-52).

As the Continental forces retreated from Canada and were driven out of New York as well, Washington was "convinced that the losses suffered throughout the 1776 campaign were largely due to insufficient means of transportation" (20:25).

The March to Cambridge

Providing for transportation was a difficult task, particularly considering the undeveloped terrain over which troops and supplies had to be transported. To provide a better understanding of the difficulties encountered, we can look at the effort required to transport artillery from Fort Ticonderoga in upstate New York to Cambridge, Massachusetts, in the winter of 1775-1776.

Fort Ticonderoga to Cambridge was a distance of more than 300 miles. Henry Knox was the man responsible for moving the artillery pieces. He started work on 1 December 1775 at Fort Ticonderoga and began the effort to remove "78 pieces from 4-pound to 24-pound guns, as well as six mortars, three howitzers, 30,000 flints and tons of muskets and cannon balls" (27:14). They initially traveled 33 miles down Lake George by boat to Fort George. Forty-two heavy sleds and 80 oxen were then required to move the equipment to Albany, New York. Once reaching Albany, everything had to be transported across the Hudson River, and it was 14 January 1776 before the group reached Westfield, Massachusetts. This was only after crossing the mountains where drag chains and ropes, anchored to one tree after another, had to be used in order to make the trip down the mountains. At Springfield, the Connecticut River had to be crossed. Fortunately it was frozen over; however, once the shore was reached, a sudden thaw bogged the entire artillery train down in mud. Knox had to wait for the ground to freeze again before moving on. It was not until 2 March 1776 that the artillery pieces were finally used by Washington against the British at Boston (27:14-15,102).

Transportation Shortages

Although obtaining supplies was always a problem, the lack of transportation intensified the problem. When Washington's army was forced to retreat from New York in 1776, numerous supplies had to be left behind for want of transportation. To compensate for this loss, the Quartermaster General had to requisition:

> . . . 200 wagons (sic), with four horses each; 50 ox teams, with 2 oxen each, for sundry uses; 50 drays, with one horse each, for various small services; 100 strong horses for the artillery; 50 horses for expresses and commissary uses; 25,000 bushels of Indian corn; 15,000 bushels of oats; 10,000 bushels of rye meal; 10,000 bushels of pelts; 1,800 tons of hay; 50 cutting boes; 2,000 axes; 2,000 wheel and hand barrows; 8,000 cords of wood; a set of carpenters tools for each regiment; a wagon master and one deputy; 2 conductors of wagons on captain's pay, allowing 10 wagons for each conductor; 5 conductors for the artillery; 100 casks of nails and spikes; 10,000 knapsacks; 10,000 camp kettles; 2 million feet of boards, planks and joists, for barracks, platforms, and so forth. (19:29).

In the winter of 1777-1778, when the Continental Army was quartered at Valley Forge, the transportation system practically collapsed as the Quartermaster General retired in the fall of 1777. With more than 5,000 troops at Valley Forge requiring supplies to survive, transportation was a necessity. "While soldiers shivered and went hungry, food rotted and clothing lay unused in depots throughout the country" (3:83). During the winter, Washington wrote Congress on numerous occasions explaining the conditions of the camps:

> What makes the matter more mortifying is that we have, I am positively assured, 10,000 complete suits ready in France and laying there because our public agents cannot agree whose business it is to ship them. A great quantity has also lain in the West Indies more than 18 months owing to the same such cause (2:102).

The problem was compounded with the British troops stationed in Philadelphia and the small townships around Valley Forge that would not provide all the necessary provisions. Those provisions that were available could not be transported due to the lack of wagons and teams. As one author wrote:

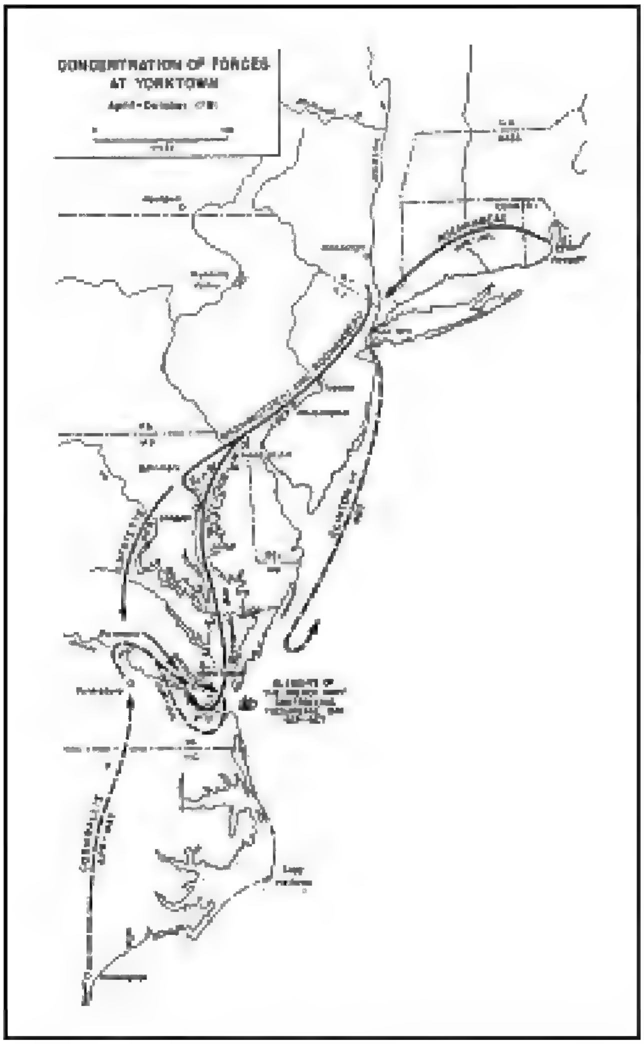
> Hunger and nakedness assailed that dreary Winter camp with all their progeny of disease and woe . . . . Thither the soldiers came with naked and bleeding feet and they sat down where destitution held court and ruled with icy scepter (22:73).

In February 1778, a new Quartermaster General was appointed, and some improvements were made. One of his accomplishments was to develop a system of grain depots using a number of small magazines in place of a few large ones. This method improved availability of grain and reduced the burden on transportation. However, the system broke down again in 1779 and 1780 when the Quartermaster General had no money and expenses could not be met. Thus, for almost "two years the main Army remained relatively idle, partially due to the lack of adequate transportation" (20:26).

Southward to Yorktown

Following 1780, the war shifted to the south. In 1781, Washington was not able to make any real progress in New York. Furthermore, the United States had made an alliance with France, and Washington had an opportunity to join forces with the French fleet and converge upon General Charles Cornwallis at Yorktown. During the summer of 1781, the French provided 3,000 troops and a fleet of ships to Washington. "Between August 13 and October 15, he (the French) would land in the Chesapeake area and join Washington in any combined operation of his choosing" (23:15).

With the French fleet of 27 ships and a combined French and American force, Washington was able to cut off Cornwallis' supplies, and on 19 October 1781, Cornwallis was forced to surrender at Yorktown. Although the War of Independence did not finally conclude until 2 years later, the British defeat at Yorktown was the last major campaign (29:334-337). In order to accomplish this feat, Washington had to move his army from New York to Yorktown, Virginia, a distance of some 450 miles, and it had to be done in 2 months if he was going to take advantage of the French fleet. Getting to Yorktown was the main problem.



Concentration of Forces at Yorktown

Distribution requirements for such an operation required the complete attention of Washington and his Quartermaster General. Fortunately, the problem of financing had been somewhat reduced due to the alliance with the French and the new Superintendent of Finance, who arranged for credit based upon his own personal assets. However, Washington still had to arrange for a force of some 7,000 troops to reach Yorktown in time to join up with the French fleet.

Leaving part of his forces in New York, Washington took 2,000 men and crossed the Hudson on 20 and 21 August. The French were not able to cross with their troops until 26 August. This week's delay for the French was caused by a variety of factors: muddy roads, lack of horses and boats, and so forth. However, after crossing the Hudson, the combined forces marched to Trenton, New Jersey, and from there, they were to travel down the Delaware River to Maryland. Due to insufficient boats, only supplies could be moved down the river as the main army marched overland. Once they arrived in Baltimore, the French fleet met them and took the majority of the army and supplies south to Williamsburg, outside of Yorktown. Finally, by 28 September, Washington had amassed a combined force of some 16,000 troops to converge upon Cornwallis at Yorktown (25:3-7).

For the first time in the war, Washington was able to take advantage of the coastal routes and move his troops by ship. The French fleet had forced the British fleet out of the Chesapeake Bay area in order to make this feat possible (25:5).

> The victory at Yorktown was a great achievement in logistics for the allied armies, a great failure for the British. Victory became a reality because of the remarkable logistics achievements that supported the tactics and strategy of the siege (25:7).

Transportation, a responsibility of the Quartermaster General, proved to be a major factor throughout the War for Independence, from the lack of it during the Canadian campaign to a well-coordinated effort with the French in the siege of Yorktown. Travel was done by foot for most of the war, and wagons and teams were forever in need to transport the supplies required. Roads were poor at best, and the British had control of the sea. Washington was constantly in want of transportation and wrote numerous letters to Congress and friends in order to improve the situation. The lack of an adequate distribution system caused numerous delays and needless suffering for his troops. Reasonably adequate transportation was only provided once in the war, at Yorktown, and that resulted in a decisive victory, which led to the end of the Revolutionary War.

Maintenance

Maintenance, as we know it today, did not exist in 1776. There were no established procedures for maintaining such things as weapons or wagons. As they broke, they were either replaced, repaired, or discarded. However, few resources were wasted:

> When cattle were slaughtered, for example, parts of the animal that weren't edible were put to other uses. Hides were either tanned in camp or else sold or exchanged for shoes or other goods. Two hides were carried with each artillery piece. These were soaked and then wrapped around the gun barrel when the piece was being fired, thus keeping the barrel from overheating. Animal fat was boiled with lye to produce soap. The hooves of the animals were boiled to produce neat's-foot oil, used to protect muskets and other metal articles from rust. And the horns of the cattle, being light to carry, perfectly shaped for pouring and resistant to fire and water, were fashioned into excellent powder containers (16:25-26).

Maintenance as a process of logistics did not really play a part in the American Revolution. It became much more apparent in World War I, the first war in which there were large expenditures of ammunition, causing the need to repair weapons and properly maintain them.

There is no doubt that logistics had a tremendous effect upon the conduct and outcome of the Revolutionary War. Washington and the Continental Army were constantly facing difficulties in every aspect of raising and sustaining a fighting

force. However, the two most critical limiting factors were acquisition and distribution. Both had a significant impact, and both nearly resulted in a disastrous end to the war effort.

After the Revolution

With the War for Independence concluded, the new republic saw little need for a large standing army. Even Washington did little to support a standing army. He expressed the view in 1783 that it was "dangerous to the liberties of a country and that the nation was too poor to maintain a standing army adequate to our defense" (1:102). As a result, on 2 June 1784, the Continental Congress reduced the Regular Army to 80 enlisted men and a few officers. The remaining personnel were to guard what was left of the military supplies at Fort Pitt and West Point. In addition, a small militia of 700 was authorized with volunteers being drawn from four states. As before, Congress remained dependent on the states to provide the military capability of the nation (7:23).

The period between the Revolutionary War and the War of 1812 was marked by numerous threats for which the military was not prepared. The militia and relatively small regular army had to contend with Indian attacks on the frontier, the Spanish in the south, and the French and English apprehending American shipping vessels. There was little action taken concerning mobilization of forces, and even the position of Quartermaster General was discontinued (26:117).

Ratification of the Constitution, however, created a central government and provided the legal basis for raising an army. The Constitution also provided for taxation to support this army. This action greatly reduced the government's dependence on the individual states and allowed for a more unified wartime response. However, although authority was provided to raise and support an army, there was little popular support to do so. Even so, with ratification of the Constitution came the formal creation of the Department of War on 7 August 1789. The department was also made an executive agency with central authority over the Army and Navy (7:26).

By August 1789, the Army consisted of about 800 men, with supplies being provided by contract. The Secretary of War was responsible for the distribution of supplies, and the Secretary of Treasury was responsible for their acquisition. In 1794, the Office of the Purveyor of Public Supplies in the Treasury and the Office of Superintendent of Military Stores in the War Department were created to handle supply functions. This arrangement remained essentially the same throughout the period before the War of 1812 (1:107).

Between 1790 and 1794, there were three major campaigns to suppress the Indian uprisings in the Northwest Territory. The first two campaigns, under Colonel Josiah Harmon and Major General Arthur St Clair, resulted in the military's being soundly beaten by the Indians. Harmon's forces were defeated primarily because of poor leadership and undisciplined troops (6:87). St Clair's defeat could be attributed not only to those factors but also to the lack of logistics support. As summarized in the official *History of Mobilization in the US Army:* "Except for the Regulars, the troops were untrained, the whole force was ill-equipped, poorly supplied and without adequate transportation" (7:29). On the third Indian campaign, the American forces were finally successful. Major General Anthony Wayne commanded the forces, and it was because of his attention to the requirements of logistics and discipline that the Indian uprisings were suppressed (7:30). This was the last military campaign of any significance organized by the government until the War of 1812.

War of 1812

Because of impressment of American sailors into the British Navy, seizure and search of American vessels, and British interference in the Indian wars, war with England seemed inevitable in 1811. As Congress met in November, the main question was how war could be declared. Historian Reginald Horseman, in *The War of 1812*, concludes "The great delay in declaring war in this session of 1811-1812 was primarily because of the lack of means with which to fight" (5:18). On 1 June 1812, President James Madison finally asked Congress to declare war on England, and on 18 June, Congress complied (5:24).

At the time, England was involved in a major conflict with Napoleon and was unable to adequately support her forces against the United States. Theoretically, the United States should have been victorious in its initial efforts directed against Canada. However, Horsman shows how, in reality, "the invasion proved to be a tale of poor supplies, inept leadership, untrained soldiers and a deficient overall strategy" (5:50). After a year and a half of fighting, American forces retreated, never again to attempt an invasion of Canada.

Military strength at the outbreak of the War of 1812 consisted of approximately 11,744 troops, which included some 5,000 new recruits. The Navy consisted of three 44-gun frigates, three 38-gun frigates, and fourteen smaller ships (1:124). A Quartermaster General was not yet appointed, and the armed forces were garrisoned in forts scattered along the western frontier. Legislation was enacted, which increased the size of the forces, and funds were provided either just before the declaration of war or on the day war was declared (7:43-45). Various logistical problems resulted, as can be seen in a review of the five basic areas of logistical support.

Industrial Base

Just prior to this period, tensions had been rising, causing Congress to examine stockpiling military arms. Recognizing American dependence on imports for arms, Jefferson wrote: "Experience has taught me that manufacturers are now as necessary to our independence as to our comfort" (6:93). With this recognition, Congress authorized the establishment of national armories.

Armories and Contractors

Two armories were designated—one at Springfield, Massachusetts, and the other at Harper's Ferry, Virginia.

However, not satisfied with the progress made in manufacturing arms at these facilities, the Secretary of War requested that Congress approve the purchase of 40,000 muskets from domestic gunsmiths. Congress approved the request, and nine contracts were let. One such contract was awarded to Eli Whitney on 14 January 1798. His contract called for 10,000 muskets at $13.40 each, with delivery of 4,000 muskets in 1799 and the remainder in 1800 (12:44-45).

Whitney had never before manufactured weapons, but he did have an established business. He experienced numerous delays and was continually asking Congress for advances. However, by the time he fulfilled his contract, he had made a lasting change in the manufacture of arms and the arms industry. He had designed a machine to make each of the parts exactly according to a pattern; all he had to do was to assemble the guns (11:232).

In another area, industry was stimulated in March 1794 as Congress authorized construction of six warships at a cost of $688,888.32. These ships were to be completed by 1795; however, due to the lack of raw material, only three were ever constructed—at an actual cost of $926,267.55—and these were not completed until 1798. The contract for the remaining three ships was cancelled as public pressure was mounting to reduce the public debt of $80 million (21:7).

Since acquisition was dependent upon contracts, the establishment of the industrial base was stimulated. Whitney clearly had a further enhancing effect upon the industrial base with his mass production techniques for weapons. In 1799, another contractor, Simeon North, also received a contract for the manufacture of 500 pistols in 1799. Both contractors were subsidized by the government, and both later used their facilities to produce commercial weapons (21:7). In 1811, more than 520 furnaces and forges were contracted for the manufacture of heavy artillery (6:98).

As the war progressed, the two armories manufactured some 42,000 muskets. The two primary contractors, Whitney and North, produced more than 15,000 muskets and 20,000 pistols, respectively (6:106-107). Both contractors were able to employ the concept of mass production and interchangeability of parts. The textile industry had also been established just prior to the war; however, it was unable to produce the cloth needed by the Army, and 26 percent still had to be imported. It is also believed much of the remaining 74 percent was imported, as the textile manufacturers refused to sell cloth to the Army because they were able to do better in the rising civilian market (7:57). In general, domestic sources could not meet all the military requirements of the War of 1812.

Requirements

Requirements for men, supplies, boats, ordnance, and so forth were all established as the need arose. On the day war was declared, Congress passed legislation for an authorized Regular Army strength of 35,603 people and gave the President authority to raise more than 130,000 federal volunteers, state militia, and Federal Rangers. Funds were also allocated to support and supply a force of this size. However, the legislation came too late, and the War Department was not set up to implement legislation of this nature (7:44-45). Requirements for training new recruits had not been established, and barracks had not been built to house them. Therefore, desertion was common, and there was at least one case in New York in which the militia refused to leave the state and invade Canada, as no provisions had been made for militia units to cross the state line (1:129).

Requirements for ships had not been established, yet the Navy was to play a major role in this war. General Hull's first attempt to invade Canada might have been realized if he had possessed naval support on Lake Erie. Horsman showed:

> Before the campaign had even started Hull had pointed out the need for an American Naval force on Lake Erie. Without such a force, he had to advance at the end of a tenuous, exposed supply line, while the British could receive supplies and reinforcements by water (5:41).

Eventually, Commodore Oliver Perry built a navy on Lake Erie. In fact, it was the combined forces of Perry and General William Harrison that won the victory over the British and gained Lake Erie as an American asset in 1813 (6:109).

Acquisition

Acquisition responsibilities had been under the Treasury Department until 1798 when they were placed under the War Department. The Treasury Department, however, continued to have the authority to inspect and revise expenditures of the War Department until 1812 (7:33). With the recreation of the Quartermaster General in March 1812, the Commissary General of Purchases was also created. This act removed the Treasury Department from having anything to do with purchases (7:43).

Procurement of supplies, however, was not affected by this change and continued to be based on the contract system with the lowest bidder being awarded the contract. The contractors were obligated to have on hand enough rations to feed the troops "at all times, providing subsistence for at least six months in advance at the most distant posts" (1:107). The majority of military supplies were centralized in a depot in Philadelphia. Here the purveyor contracted for all clothing, camp utensils, military stores, medicines, and hospital stores. The Superintendent of Military Stores collected and issued these items when needed by the troops (1:107).

Although a system was established to handle the acquisition of military supplies, the delay in establishing requirements naturally delayed the acquisition process, and this had a significant effect upon the war. General Hull continued to delay his attack due to his perceived lack of supplies in the northwest. General Winfield Scott's forces in New York fought in the gray of the New York militia due to an inadequate supply of clothing, and General Andrew Jackson in the South frequently outdistanced his supply lines. On practically all fronts of the war, commanders had to resort to local purchases of necessary supplies (1:139). This was particularly true for troop rations.

Rations were under contract not only to be purchased but also delivered to the front. However, as during the Revolutionary War, the system did not work very well:

> Contractors were loath to deliver on a fixed-price quotation unless prices were low and a sizeable profit was ensured . . . . The quality of food was generally poor due to the number of middlemen involved in its purchase and to their practice of skimping on quality so as to secure a maximum return to themselves (26:117).

The failure of contracts to supply rations on a timely basis frequently caused delays in the execution of campaigns. One such delay occurred in the summer of 1812 as General Dearborn led an invasion across the Niagara River into Canada. It was mid-October before supplies were available. Then, once provisions arrived, the militia refused to enter foreign territory (6:110).

The acquisition of small arms was somewhat more satisfactory since the national armories were fairly well established prior to the war. However, the acquisition of heavy artillery remained a problem.

Just as it had done during the Revolutionary War, inflation nearly brought the war effort to a standstill. With the blockade of American ports and the lack of trade with Europe, the national economy had deteriorated. This, in conjunction with the lack of success in the early stages of the war, caused rising inflation. Finally, with the burning of Washington in 1814, several banks suspended specie payments. As in the Revolutionary War with Robert Morris, the nation's financial health was saved by the personal efforts of James Monroe (appointed Secretary of War in September 1814). It was through his personal guarantee that loans were granted (6:104).

Distribution

Distribution of supplies was a problem from the onset of hostilities. The initial strategy called for an invasion of Canada, and General Hull, governor of the Michigan Territory, was given command with orders to secure the Detroit area. The campaign had barely started when General Hull surrendered. Hull's primary fear lay in his exposed supply line from the east to Pittsburgh and then to the front. General Harrison took command after Hull and experienced the same problems. He reflected that his "troops marched from Kentucky in August to relieve General Hull and the clothing for them left Philadelphia late in November" (6:109). Not wanting to delay any longer, General Harrison resorted to purchasing food, clothing, and cartridges from the local populace (6:109).

Meanwhile, the war was exploding on other fronts with an expedition planned against Montreal in 1813. Furthermore, there was an outbreak of Indian warfare in the South. Fighting in all three areas placed a tremendous burden on transportation. Supplies had to be moved through wilderness, for which roads had to be built. For this reason, ammunition and clothing resupply proved totally inadequate (1:139).

An attempt to improve the system was made as the war expanded. Initially, all new supplies were delivered to the main depot in Philadelphia. In order to cut down on distribution requirements, the Commissary General for Purchases decentralized the system and directed nine depots be

Across the Ocean—Napolelon Overtaxed His Logistics Capacity

It should be recognized, however, that the worst shortages were experienced during the first 2 weeks of the advance (that is, precisely the period for which Napoleon had made his most careful and extensive preparations) and that the situation gradually improved afterwards. Also, the *Grande Armee's* problems were at all times, including the retreat from Moscow, largely due to bad discipline. This, of course, was itself partly due to logistics shortages. However, the fact remains that those units with commanders who were strict disciplinarians (for example, Davout's) consistently did better than the rest, while the Guard even managed to keep such good order that, far from running away, the inhabitants enthusiastically welcomed it. Nor is it true, as is so often maintained, that the country as a whole was too poor to support an army. Writing from Drissa early in July, Murat—operating as he was in an area which Pfuel had selected for the erection of his fortified camp precisely because it was supposed to be without resources—informed Napoleon that while the region around was tolerably well provided it would be possible to exploit it only after a proper administration was set up and an end put to the troop's marauding.

That the *Grande Armee* suffered enormous losses during its march to Moscow is true, as is the fact that hunger and its consequences—desertion and disease—played a large part in causing these losses. It would, however, be unwise to attribute this solely to the problems of supply. The need to protect enormously long lines of communication and to leave garrisons behind and the effect of distance *per se* were also factors of major importance. As regards the army's materiel losses, there is reason to believe much, if not most, of the equipment abandoned on the way to Moscow was later retrieved. In 1812, Napoleon's main force marched 600 miles, fought two major battles (at Smolensk and at Borodino) on the way, and still had a third of its number left when entering Moscow. In 1870, as in 1914, the Germans, operating over incomparably smaller distances, in very rich country and supported by a supply organization that became the model for all subsequent conquerors, reached Paris and the Marne respectively with only about half of their effectiveness. Compared with these performances, excellent as they were, the French Army of 1812, for all its supposedly worthless service of supply, did not do too badly.

Martin van Crevald
Supplying War

established in each of the nine military districts. The idea had merit and foreshadowed future regional approaches for distribution. Unfortunately, no real accounting system was established, and no one had any idea as to what supplies were required and where they were needed (7:58-59).

Maintenance

Maintaining the forces proved to be a formidable task for field commanders. Food, clothing, equipment, and arms were sorely inadequate. As during the Revolutionary War, commanders frequently resorted to procuring these items from the local populace. Aside from maintaining the force, a beginning was evident for the maintenance of ordnance. The Department of Ordnance was created with overall responsibility for "receipt, storage, care, and repair of munitions; inspection of shells, shot, and powder and for overseeing the construction of gun carriages, ammunition wagons, and other equipment for cannon and ordnance" (26:118).

Despite logistical difficulties, the American forces won the War of 1812, just as they overcame disadvantages to win the War for Independence. A large part of this success must be attributed to the determination of a few. Clearly, though, many of the difficulties encountered should have been avoided, since the same problems had been experienced just 35 years earlier.

Post-War Reductions

Following the War of 1812, there emerged another period in which the military was reduced, but not to the extent that it had been after the Revolutionary War. Initially, the military and its staff were reduced to an authorized strength of 10,000 men. However, few people were concerned about future mobilization, and Congress, in March 1821, further reduced the Army to 6,183 men. Throughout this period, there was little change in the authorized strength of the Army. Even when war with Mexico was declared, the Army's authorized strength had risen to only 8,619 (7:61-68).

There was, however, an attempt made to maintain the military staff. Secretary of War William H. Crawford put forth a strong argument to Congress:

> The experience of the first two campaigns of the last war, which has furnished volumes of evidence upon this subject, had incontestably established not only the expediency, but the necessity of giving to the military establishment in the time of peace, the organization which it must have to render it efficient in a state of war (6:112).

John C. Calhoun followed Crawford as Secretary of War in 1817. He also felt strongly about the staff as he wrote: "In fact, no part of our military organization requires more attention in peace than the general staff" (6:113). The efforts of these two men led to the passage of legislation in 1816 and in 1818. The Act of 1816 provided a Quartermaster General for both the Division of the North and the Division of the South, and in 1818, these two were again combined into one Quartermaster General (26:118).

The Seminole Wars

Besides some minor Indian uprisings along the western frontier, there were only two major military campaigns prior to the Mexican War of 1846: the First Seminole War (1817-1818) and the Second Seminole War (1836-1842). Acquisition was a problem in the first campaign, and distribution was the main problem in the second campaign.

Acquisition of supplies was the primary problem during the First Seminole War. General Jackson led the campaign and had made arrangements for supplies prior to his departure from Tennessee. Upon arriving in Georgia, he found that the contractors had failed to provide the necessary rations. "For more than a thousand men, he reported to Calhoun, there was not a barrel of flour or a bushel of corn" (1:152). Once again, Jackson resorted to local procurement in order to supply the needs of his army, just as he had done during the Battle of New Orleans in 1814. As a result of this incident, Congress finally authorized the Subsistence Department, headed by the Commissary General of Subsistence (1:154). Recognizing the importance of subsistence is what finally led to the Army's victory in 1842 after 6 years of fighting in the Second Seminole War. James Hudson concluded: "In the final campaign, Colonel Worth resorted to a series of summer offensives aimed at destroying the Indian's subsistence, so that the issue finally was settled by striking at enemy logistical resources" (6:121).

While procurement was a major shortcoming in the first war, transportation proved to be a stumbling block in the Second Seminole War. In the fall of 1840, five government-owned and six chartered steamboats were in regular service, transporting mostly forage for the 2,140 horses and mules used in Florida (6:120). Yet transportation was a major problem for General Scott in the early years of the war. It took him from 21 January to 5 April 1836 to begin his campaign in Florida because of problems encountered in moving troops over primitive and unexplored terrain. By then, the Indians had been able to disappear into the interior of Florida. Although supplies were available, wagons, roads, and Army maps were sorely lacking, and Scott was unable to pursue the Indians (1:159-160).

Mexican War

The war with Mexico began, as previous wars had, with little or no preparation. However, this time, the American economy *was* able to support a war. A second industrial base was emerging, and America had control of the seas. Seapower enabled the United States to transport troops and supplies despite the great distances involved. Overall, the Armed Forces were better equipped and trained than those of Mexico. This is not to say that hardships did not exist. Otis Singletary explained:

> Though few Americans were willing to face them, the problems of waging offensive war against Mexico were staggering. The great distances involved, the rugged and forbidding mountain ranges, the problems of sustaining an army on arid desert terrain and the ever present danger of

attack by the most deadly and dependable of Mexican allies, yellow fever, presented difficulties of no small dimensions (9:23).

More than 10,790 men died from disease and exposure while only 1,548 were killed in action out of a total force of some 100,182 troops (4:110).

Although war with Mexico had been expected since Texas had gained its independence in 1836, no real plans had been made for war. Even when Texas joined the Union in 1845, little preparation was made, yet there was every indication that war was imminent. Little thought was given to the condition of roads, the availability of water, transportation, and supplies (9:25). In their study of military mobilization from the Revolution to World War II, Kreidberg and Henry point out that, although a general staff was in existence:

> . . . there does not seem to have been a single directive to any of the War Department Staff bureaus calling for procurement or logistics planning of any other kind, nor is there any indication that any of the bureaus prepared mobilization plans on their own initiative (7:66).

Yet a limited mobilization had in fact commenced. Secretary of War William Marcy, under President James Polk, had directed General Zachary Taylor to move his army to Corpus Christi, Texas. By 15 October 1845, General Taylor had 3,860 troops, about half of the Regular Army's strength, at Corpus Christi (1:67). Then, on 24 April 1846, Mexican troops crossed the Rio Grande and attacked an American patrol, initiating war with Mexico (4:70).

The Mexican War consisted primarily of five major drives—four into Mexico and one into California. The most important campaigns were those of General Taylor and General Scott. However, the other three were also noteworthy because of the great distances over which the soldiers marched. In 1846, General Kearny's Army of the West marched in 6 months from Fort Leavenworth, Kansas, to San Diego, California. Colonel Doniphas also departed from Fort Leavenworth and traveled some 3,500 miles before reaching Reynosa, Mexico, in 1847. In 1846, General Wool moved his forces from San Antonio, Texas, some 900 miles, to Saltillo, Mexico, in 1846. These marches contributed greatly to the successful outcome of the war and in claiming the southwest as American territory (6:146-147).

Industrial Base

Following the War of 1812, the industrial base continued to grow. More arsenals and armories were added to the National Armory System, and innovations continued.

After Whitney and North's introduction of mass production for firearms, a technical breakthrough was achieved with Hancock Hall's patent of a breech-loading flintlock. Hall, working at the Harper's Ferry Armory, also created the machine tools to mass-produce his rifles. Hall's firearm was designated the M1819 and was the first mass-produced firearm manufactured entirely by machine (12:46).

Other innovations were also evident: Asa Walter's patented trip hammer, used to forge 16 to 18 gun barrels daily, Thomas Blanchard's stock-making machine, and James Green's improved barrel-boring mill. The mass production of firearms with interchangeable parts improved precision, increased productivity, and greatly enhanced the US machine tool industry. The military concept of interchangeability was introduced in the sewing machine industry in 1846 and in clock-making in 1848. Even the textile industry borrowed liberally from the arms industry. The firearms industry drove the technological revolution as it encouraged inventions, innovations, and improvisations along with precision and increased productivity (12:46-47).

With the machinery then available for manufacturing weapons, the Springfield Armory produced 14,200 muskets, and the Harper's Ferry Armory produced 12,000 muskets from 1 July 1846 to 30 June 1847 (6:130-131). Private contractors provided artillery, ammunition, and gunpowder in sufficient quantity to meet the needs of the war. Even the textile industry was able to meet clothing requirements. At this point, a gradual shift began from an agricultural to a manufacturing society. This change would play an even more significant part in the Civil War.

Requirements

Requirements, as in the past, were left to the last as planning for the Army's needs was still not done on a timely basis. At the onset of the war, initial strength requirements were estimated at 50,000 men (7:70). This figure grew to more than 100,000 before the war concluded. In addition to combat casualties, about 11,000 soldiers died from disease and exposure. The United States was simply not prepared to employ troops in a semitropical climate:

> Officials in Washington supplied tents that were inadequate for the different types of climate encountered, clothing that was designed for cooler temperatures; and those officials made little effort to educate the raw recruits to what they had to face (4:110).

As General Scott moved toward Mexico City, he reported to the Secretary of War on 4 June, "one thousand men were bedridden in Vera Cruz, one thousand were reported sick and wounded in Jalapa, and 1,014 of his immediate forces were on sick report at Puebla" (4:114). Scott believed the various diseases were brought on by the extreme climate, inadequate clothing, and lack of salt meat (4:115).

Logistics support was generally erratic due to the general staff's lack of adequate planning. An aspect of logistical planning first emerging in the Mexican War was the requirement for a variety of ammunition. In previous wars, the musket was generally used; however, with the Mexican War, a variety of personal weapons began to enter the inventory. Flintlock muskets were still used by the Regular Army; the volunteers brought with them Hall's breech-loading firearm, the Colt revolving pistol and rifle, and the carbine. This greatly compounded supply requirements for both

An early base exchange—the fort store at Fort Dodge, Kansas, in the 1850s.

ammunition and spare parts (6:129). The different types of ordnance, along with the different terrain and climate, also compounded acquisition problems.

Acquisition

One area that had improved since the last war concerned the issue of long-term contracts for acquisition of arms. Secretary of War Calhoun recognized the benefits of renewing contracts with vendors who had performed satisfactorily. This arrangement led to the establishment of an arms manufacturing industry and to what was seen as healthy competition between armories and contracted production of arms. However, at the beginning of the Mexican War, procurement was again done on a *catchup* basis.

With the demise of the Purchasing Department in 1842, the various bureau chiefs were left to procure their individual needs. They did this without any plans as to how supplies would be used or even how to determine what was really needed (6:125; 1:77). Supplies were often bought at outrageous prices as the Quartermaster General ordered officers to procure wagons, boats, and camp equipment at any price. Oddly, civilian standards of living were often applied. "The troops in the field were provided with dancing girls, bars, theaters, newspapers, ice, liquor, vaudeville, gambling houses, fancy tobacco, fancy groceries, camp followers, and so forth." (7:79-80).

Clothing, however, was another matter. Although the regular forces were provided uniforms, volunteers received a clothing allowance and were required to provide their own uniforms. Unfortunately, volunteers either did not use the money for that purpose, or they bought cheap clothing that did not meet their needs. Soon after the war was over, Congress passed an act that would provide clothing to both the volunteer and regular forces. The lack of adequate clothing contributed to unnecessary suffering. Most unfortunate was the fact clothing was often actually available, but the field commanders were not authorized to issue it (4:118).

Overall, acquisition was handled by contract as it had been in the past. Contracts were used to procure arms, wagons, boats, clothing, food, and camp equipment. Generally, the troops were fairly well supplied. The costs, however, were significantly higher than expected. The initial allocation of funds appropriated by Congress was $10 million (7:70). Total expenditures for the war exceeded $39 million per year. Within the Quartermaster General's Department in fiscal year 1846-1847, some $3.96 million was spent to transport the troops. Expenditures for subsistence amounted to $1.754 million and for ordnance another $924,600 (6:136). Fortunately, the availability of money was not a major problem in the Mexican War.

Distribution

Distribution problems were greatly reduced during the conflict with Mexico. In the past, transportation of troops and supplies had proven to be a major obstacle and had a tremendous impact on strategy and tactics. Distribution problems were present in this war, but they were due more to inadequate planning than anything else.

The distance from Washington to Mexico, of course, presented endless challenges in communications. There were no major roads leading to Mexico, and there were no railroads. The first railroad had opened in 1830, but it was located in the Northeast (11:329). In order to move troops and supplies, the steamship and sailing ship provided the primary means of transportation. Difficulties were not so much in getting the troops and supplies to Mexico but in handling problems that arose after they arrived.

During the first engagements, at Palo Alto and Resaca de la Palma on 8 and 9 May 1846, respectively, General Taylor was prevented from pursuing the enemy due to a lack of pontoon bridge equipment needed to cross the Rio Grande. Although Taylor had requested this equipment, there were no funds in the Corps of Engineers to pay for it. Also, it must be pointed out that Taylor seems to have made no effort prior to these engagements. (6:133-139).

These two initial battles were fought with about 3,000 regular soldiers. General Taylor had previously put out a call for militia, and by June, he had 12,601 militiamen but no transportation to support them. As a result, all 12,601 had to

Monterrey as it appeared to General Taylor in 1846. He had been beset by logistical troubles, culminating in a shortage of wagons for the final approach to Monterrey. This limited his force to 6,000 against 7,000–9,000 Mexican defenders.

be demobilized without ever being employed (7:75). Again, little preplanning had been made for these troops, and in reality, Taylor ended up *troop poor*.

General Taylor's next objective was to march to Monterrey, a trip that was delayed at least twice due to lack of transportation. The first leg of the journey concerned setting up a supply base at Camargo about 130 miles up river on the Rio Grande. For this effort, he needed shallow draft steamboats, and these were not available until July. Once he reached Camargo, wagons and teams were needed to travel over land to Monterrey. Since there was not a sufficient quantity, Taylor had to requisition some 1,500 Mexican pack mules and oxcarts to move his supplies (1:168-169). Again, part of the distribution problem was Taylor's failure to requisition the things he needed when needed.

In contrast was General Scott's march to Mexico City. General Scott's landing at Vera Cruz was classified as the first major amphibious landing. With a force of 12,600 men, Scott was able to put more than 10,000 on shore in less than 4 hours with some 65 surf boats, which had been towed there for that purpose. On 27 March 1847, Scott set up a supply base at Vera Cruz for his move to Mexico City (1:174).

In both Taylor's and Scott's campaigns, we saw the first real effort for providing supplies by steamboat—from New Orleans and Pensacola to Vera Cruz and up the Rio Grande. Overall, the system worked fairly well.

Maintenance

The use of a variety of weapons and the interchangeability of parts produced the necessity for maintenance. Spare parts were required, and weapons had to be maintained with greater care than was required for the musket.

The national armories continued to meet ordnance needs. In addition to manufacturing arms, they also had to manufacture parts. The Harper's Ferry Armory manufactured some 1,530 components for 1822 and 1840 model muskets. These components were issued to the arsenals and the armies for repairing and maintaining arms (6:131).

With the peace treaty in 1848, the United States had greatly expanded its territory. The Rio Grande was recognized as the boundary of Texas; and Mexico ceded the current states of New Mexico, Arizona, Utah, Nevada, California, and parts of Wyoming and Colorado. However, once again, the Army reverted to a peacetime force of less than the 10,000 authorized in 1815 (1:179-180).

Antebellum Industrial Expansion

General Winfield Scott was the Secretary of War throughout this period, and the organization of the War Department remained fairly constant during his tenure. By 1860, there were 1,108 officers and 15,259 enlisted men in the Regular Army (7:85-88). The only military operations the Army faced between the Mexican and Civil Wars were the various Indian wars that erupted as the settlers continued to expand westward.

Transportation remained a problem. Steamboats and sailing ships were used extensively around the coastal regions and along major rivers, but inland travel was still difficult. By 1850, there were 67 western frontier posts that had to be supplied with food and goods. To support these posts, General Jesup, the Quartermaster General, relied heavily upon private transportation. Private contractors carried almost five times as much supplies to these outlying posts as did the government (13:155). However, one of the most rapidly expanding transportation systems was the railroad. In 1850, there were only 9,021 miles of track in the United States. This figure more than tripled by 1860 to include some 30,626 miles of rail (11:520). The railroad was to play a significant role in the Civil War.

Little was accomplished in the realms of requirements, maintenance, and procurement. The only requirements concerned the need to maintain a force in the West to put down the Indian uprisings. For the most part, the existing force was able to handle this. Maintenance was still not a major issue, and procurement continued on the contract system.

The industrial base, however, continued to grow. Prior to the Mexican War, the industrial base was stimulated by weapons development. After the war, individual innovation provided the stimulus. The number of patented inventions alone increased from 993 in 1850 to 4,778 in 1860. By 1860, the country was changing from an agricultural to a manufacturing society, and the value of manufactured products was almost equal to the value of agricultural goods—the figures being $1,885,861,000 and $1,910,000,000 respectively (11:460-462). The vast majority of these changes were concentrated in the northeast and were to have an important impact during the Civil War.

Within the arms industry, there were some notable changes. In 1854, Congress appropriated $90,000 for testing and

The Camel Express–1857. Seventy-five camels were purchased, complete with Turkish and Greek drivers, to transport army supplies through the parched Southwest. Though effective, camel power did not catch on and was virtually nonexistent by the Civil War years when railroads became more prevalent.

purchasing an acceptable breech-load rifle. By 1858, the Army had its first repeating rifle, and although not totally successful, it represented a major step toward improved weapons. In 1858, the metallic cartridge was invented. With these changes, logistics problems were compounded due to the increased capability to expend ammunition. Improvements were also made in field artillery with the adoption of the Napoleon gun in 1857. This gun was classified as a general purpose weapon that could use solid shot, canister, grape, explosive shell, spherical case, and mortar shell. Use of this weapon simplified ammunition requirements (6:157-158).

Although the country was expanding and manufacturing was rapidly increasing, there was little change in the military profile. By 1860, the Regular Army had not increased significantly in size, and the staff had not given any consideration to future conflicts. Yet the Civil War was close at hand and would be classified as the first total war in the modern sense.

Chapter Two

Logistics in Transition: The Face of War Widens

1860-1900

US military logistics development during this period was characterized by extremes. The historical suspicion of large standing armies was demonstrated again after the Mexican War and resulted in a drawdown that left only a small military force in being. The outbreak of the Civil War and the magnitude of that conflict surged the military in 4 years to a force of more than 1 million. During the postwar period, history repeated itself. With no serious external threat, the standing army was allowed to dwindle to a size deemed adequate for frontier protection purposes. By 1900, the Spanish-American conflict resulted in US military forces rapidly mobilizing and venturing onto two oceans on a moderate scale. Obviously, the logistics environment needed to support a conflict of Civil War magnitude would be quite different from that required to support a few scattered frontier posts or an army and navy deployed simultaneously on two oceans. The age of industrialization began its impact on warfare.

The growth of industrial activity was a factor in the logistics extremes as it both contributed to and benefited from the requirements and experiences of war (2:136). The existence of steam-powered rail systems was a key factor in the conduct and outcome of the Civil War. In turn, wartime activity spurred westward growth of the rails. Faster, more reliable communications, especially the telegraph, became a factor in wartime operations and logistics support. Improved weapons with greater rates of fire and subsequent increased support requirements made added logistics capability a necessity. Steam-powered ships produced by American yards began to challenge the traditional maritime powers. Ironclad ships appeared on both sides of the conflict. In short, industrialization both stimulated and enabled logistics development during the period.

This chapter deals with a dynamic period of logistics history by describing the original logistics environment that existed and illustrating how the necessities of war and the influences of industrialization changed that environment. The primary focus is on the significant US military actions of the time: the Civil War, the Indian campaigns, and the brief Spanish-American episode that closed the period. Additionally, the impact of logistics on field operations will be highlighted to allow the reader to gain an appreciation for logistical contributions to the operational arena of strategy and tactics. In many ways, logisticians of the day experienced problems and operated under procedures not unfamiliar to contemporary logisticians.

Civil War

In 1860, there was no popular consensus that armed conflict would result from the increasingly heated arguments between northern and southern interests. Even as these arguments grew in strength and a rift between the two factions began to widen, there was little significant comprehension, on either side, of the magnitude of the war to come. One exception was William Tecumseh Sherman. More than most, he understood what it would take to defeat the South and where much of the initial war effort would occur—in the river arena of the West (8:138,161). Unfortunately, his position as a relatively unknown, inactive Army officer in charge of a Louisiana military school gave him neither the credibility nor the forum to be influential in the War Department.

This situation was worsened by the size of the standing army—slightly more than 16,000 (22:25). This force was oriented almost totally toward cavalry operations and frontier protection. Many armories existed among the various states and were reasonably well stocked with arms and ammunition. However, those located in Southern and Southern-leaning states were afforded no extraordinary measures to prevent their falling into Southern hands at the onset of hostilities—a political decision made to avoid inflaming Southern emotions. Additionally, the Army was woefully short of anything resembling a logistics cadre to deal with upcoming requirements.

A Flawed Mobilization

When hostilities began, initial logistics preparations and actions displayed the traditional and characteristic American unpreparedness for war. The situation was so chaotic that it was characterized as "one of the sorriest examples of mobilization ever to occur in this country" (23:123). President Lincoln observed, "One of the greatest perplexities of the government is to avoid receiving troops faster than it can provide for them" (6:161). Part of the problem was that no such thing as systematic war planning existed within the War Department prior to the Civil War (6:171). Therefore, no

logistics planning existed either. Initial attempts to raise manpower were aimed at the various state and territorial governors. Few of these military forces were initially well equipped, clothed, or capable of being fed as they reported to camps as directed by the War Department.

The inability of the War Department to remedy this situation with its own limited resources dictated delegating to the states the essential tasks of feeding, clothing, and equipping the troops with subsequent reimbursement by the federal Government (23:122). The results were less than desirable because of the variety of support furnished by the states. Some were wealthy and could treat their soldiers well; others were not so fortunate. A lack of common uniforms among the various units led to confusion on the battlefield, especially during early campaigns (14:93). Additionally, state loyalties and suspicion of the central government made integration of mobilization efforts almost impossible until the seriousness of the situation was demonstrated in the first few battles (6:163).

Food supply was about the only area where minimal problems were experienced during initial phases of mobilization. Rations were plain and, for the most part, not highly perishable. Usually obtained from bids in local areas by officers of the Commissary Department, rations were easily moved to camp via railroads, wagon trains, or water routes (23:123). The authorized government daily ration in 1861 was one 16-ounce hardtack biscuit or 22 ounces of bread or flour, a 20-ounce piece of fresh or salt meat, or 12 ounces of bacon (9:40). It was generally acknowledged this ration was inadequate to prevent scurvy (23:124).

The Sutler and His Wares

Such would have been the case were it not for the existence of an enterprising group of businessmen known as sutlers. These vendors followed the army and sold a wide variety of goods directly to the soldiers. Sutlers enjoyed legal status under military law but were theoretically subject to price controls. They were at once a source of joy and misery to the soldier. The price controls were ineffective, and a 300 percent profit was not uncommon (9:57). Soldiers in debt to a sutler could have their pay tapped. The quality of sutler-purchased food often contributed to sickness and disease. Endless arrays of goods tempted the weak—among the offerings of one sutler was Piercy's Patented Pile Pipes for application of ointment to "army officers who are in the saddle" (9:18). Enlisted men were not afflicted; they walked.

Sutlers and their wares supporting the 1st Brigade at Brandy Station Virginia.

Frequently, sutler activities were so pervasive that they hindered the military effort. They took up space on available transport networks and sutler horse teams were allowed higher fodder consumption rates than were permitted for military forces. So profitable were these operations that some chartered their own sailing ships to carry goods to the front (9:78). So large were sutler activities that in 1862 Commanding General Halleck, pressed to reduce the mushrooming size of baggage trains, issued a general order to his subordinate commanders to stop carrying sutler wares (misrepresented as quartermaster or commissary supplies) in regimental or quartermaster wagons (9:74).

However, for all their drawbacks, sutler services may have been more beneficial than generally appreciated. For the most part, they gave troops access to articles and food that the government could not or would not furnish. Without them, the officially discouraged practice of foraging might have been a larger problem than it was, as troops used this age-old practice to supplement rations (23:124). An example in the Vicksburg campaign found a Union general catching some men cutting up a hog shortly after he had issued an order against killing livestock. When challenged, the men told him they had been attacked by a drove of wild hogs and had fired only in self-defense, killing one. "The wise general rode on" (14:240).

Foraging, of course, would be an official and important part of Sherman's logistics support later in the war when his army became self-contained and void of external supply lines. Although food was generally available from one source or another, the same was not true for other necessities. The War Department had no reserve supplies of shoes, blankets, clothing, mess equipment or firearms (23:124).

Determination of requirements for these items was not a sophisticated process and usually took one of two forms. Articles were purchased through either a straightforward computation of manpower multiplied by some usage factor—that is, a pair of shoes every 2 months and a uniform every 4 (13:241)—or instructions were given to "buy all that could be had" (11:253). The problem was not in determining needs but in implementing decisions. In effect, shortages drove procedures; established peacetime procedures (centralized control and negotiation) were ignored because they did not work.

Purchasing Scandals

In the rush to mobilize and with much purchasing authority delegated to the states, a flurry of uncoordinated and unnecessary competitive buying began. Fraud, waste, and abuse were inevitable. In New York, a federal officer attempting to negotiate an arms purchase was being outbid by agents from states and cities and by other military (state militia)

officers (11:258). In the West, General John Fremont's notoriously corrupt buyers made an outrageous weapons buy. The corps quartermaster bought 5,000 Halls carbines from a Pennsylvania dealer for $22 each. Subsequent review of this purchase revealed these same guns had been sold earlier as excess by the Ordnance Bureau to a New Hampshire buyer for $3.50 each. That buyer had repaired and modified the lot for about $1.00 each and sold them to the same Pennsylvania dealer for $12.50 each (14:59). The final irony is that the federal Government paid all bills inflated in this manner (11:258). Use of the newly developed telegraph allowed buyers, such as Fremont's quartermaster, to close contracts with vendors a thousand miles away (11:253).

With a poorly organized inspection system, faith became a prime ingredient in buyer-vendor relations. Frequently, this faith was violated and nowhere more than in the procurement of horses. In St Louis, Fremont's buyers' open and shameless abuse frequently resulted in buying items without bids or inspection but with kickbacks. One purchase of 411 horses included only 76 useful animals (5 were dead), and the unit cost was $11 more than the going rate (11:272).

Other examples of horse buying scandals abound. The causes were varied. Political influence favored higher prices for some areas (13:475). Horses were purchased in Pennsylvania, for example, and incurred additional transportation costs en route to Illinois or Indiana even though better horses were available there at lower cost (11:264). So blatant were excesses that one subcontractor boasted that he could bribe army inspectors enough to sell blind horses (11:265). Unfortunately, so many horses were required (1,500 per week for just the Army of the Potomac in 1862) that inspectors, poorly qualified anyway, were simply not very selective. One man, watching an inspection of horses, heard his neighbor remark on the arrival of a horse he had known for 29 years (19:258). With such examples, it is not difficult to envision a call for reform of the Army procurement apparatus.

Three events in 1861 and 1862 shaped a more efficient system.: Congressional investigation (Van Wyck Commission) resulted in limits on contracting methods, Edwin Stanton took over as the Secretary of War, and a career soldier named Montgomery Meigs was given control of the Army Quartermaster Bureau. Van Wyck Commission actions banned sublets of awarded contracts, required reporting of awards to Congress, and made contractors subject to military law and court martial if indicted for fraud (14:74). Stanton provided the guidance and direction required for the War Department as it emerged from under the vacillation of previous leadership. Meigs, in his capacity as Army Quartermaster, became the dominant figure in logistical support of the war effort (13:290).

A Great Quartermaster

The scope of Meigs' job, even though limited to the Quartermaster Bureau, came to include almost half the field of Northern industry. Unfortunately, he found that his work could not always be properly coordinated with a centralized office or master planner for all Army logistics needs (13:291). In fact, no agency existed for any systematic formulation of supply needs determined in conjunction with the size and mission of the Army. Supply was not even quartermaster-unique, as at least three other bureau chiefs (Ordnance, Subsistence, and Medical) had their own supply officers. To compound matters, the quartermaster was chartered to transport all purchases by all bureaus from the depots to the camps, to troops on the march, and to the front (19:217-218). This type of organization left Meigs primarily in a role as an advisor and overseer. With a shortage of men for clerical work, he hired substantial numbers of women into the Bureau.

Eventually Meig's Quartermaster Bureau would oversee the expenditure of more than $1.5 billion or almost half the direct cost of the war (13:295). In this capacity, he faced some familiar themes. Whatever government contract policy was shaped would have dramatic impact on the US economy. During early frantic buying periods and after he was criticized for buying some critical supplies from foreign sources, Meigs remarked: "We must bear the clamor of fools who would pick flaws in a pin while the country hangs in the balance" (13:291). He preached a message of conservation to undisciplined troops who through neglect had "killed ten times as many horses for us as for the rebels" (13:292).

Fighting Red Tape

Overall progress in logistics matters was impeded by red tape. Existing regulations required contracting or disbursing officers to settle accounts by sending them directly to the head of their respective bureaus, which reviewed them for propriety before certifying them to the Treasury Department for payment (22:31). In today's automated office environment, this practice would not be the obstacle it was in the 1860s when all entries were made by hand in great detail in large bound ledgers. This procedure changed during the war, but the administrative bureau was still required to perform the validation review prior to Treasury action.

Eventually, depots were established at Boston, New York, Cincinnati, Louisville, Indianapolis, St Louis, Detroit, and Springfield to augment the main depot in Philadelphia (23:125). Actual contracting was little different from earlier periods, except for use of the telegraph (6:182). Procurement responsibility in the bureaus followed commodity lines. The quartermaster bought uniforms, Ordnance bought arms and ammo, and Subsistence bought rations. When crossover issues were raised (horses for artillery), they were settled by the ultimate destination or use to which the item was to be put (6:169). Quite early in the war, ordnance was centrally procured to eliminate competition between state and federal buyers and ensure standardization (13:350).

The common procedure used to obtain supplies was for the chief quartermaster of a principal depot or territorial military department to let bids, contract for, and buy required items. The same people supervised, inspected, and stored supplies. They also arranged transport to advanced depots near the theater of need and ultimately to the actual unit quartermaster

Command Control of Logistics

The logistics support that may be considered inadequate by a timid or mediocre commander may be adequate for a bold and competent commander who understands the nature and sources of flexibility, provided he has adequate command control of a flexible logistics system.

This is strikingly illustrated by the contrast between the attitude and accomplishments of General George B. McClellan in Virginia in 1862 and the performance of General Grant before Vicksburg in 1863. Of the former, Dupuy and Dupuy wrote:

> But the student of history, remembering the later meticulous methodology of McClellan as leader of the Army of the Potomac and his almost fanatical insistence on over adequate supply, maintenance and equipment, will realize how McClellan had been influenced by the study of the Crimean War with its horrible examples of logistical mismanagement. . .he would forge a magnificent instrument of war; he would then be so preoccupied in the technical logistical phases of its maintenance that, unable to see the woods for the trees, George B. McClellan would go down in history as a failure in strategy and grand tactics.

Of the latter, the same authors also wrote:

> Meanwhile Grant had made his decision. His immediate enemy had retreated toward Vicksburg; he knew Johnston was assembling another enemy force at Jackson. He moved between them in Napoleonic fashion of two wings with a central reserve . . . There were rations for five days, there was a wagon train of 120 vehicles; that was all. Communications? There were none. The army, some 41,000 strong, would live off the country!

And of the same campaign, Liddell Hart wrote:

> Grant's bold move had succeeded thus far, but the worst risk was still ahead. Supplies were limited, the troops already on short rations, and almost without transport until Sherman, arriving on May 6, brought the first part of a train of several hundred wagons stacked with provisions from Miliken's Bend.

The fight for supplies in the struggle for Richmond. On 29 June 1862, General Magruder led the Confederates three times against this wagon train position of McClellan's. At dusk, the camp broke and, in their impatience to move swiftly to Savage Station, they left behind large quantities of supplies for the eager rebels.

> His rapidity over bad roads was not his least contribution to the success of the campaign, and with his keen insight into the supply factor he had ordered Blair to "keep . . . hauling stores forward," and likewise instructed all his regimental commanders that "every ounce of food must be economized." He restricted the transport of his men to two wagons per regiment, exclusively loaded with provisions and ammunition and even ventured to send Grant a friendly hint that he should take measures to regulate supplies and to control the "everyone for himself" competition between the different corps and divisions. "Stop all troops till your army is partially supplied with wagons, and then act as quickly as possible, for this road will be jammed as sure as life if you attempt to supply 50,000 men by one single road." Grant laconically replied that he did not propose such an attempt, but intended instead to get up what he could and then depend on the country.

Rear Admiral Henry E. Eccles
Military Concepts and Philosophy, 1965

Log cabins and *corduroy* walkways were built enthusiastically by camp soldiers to provide a drier, more mud-free dining area in the field.

for distribution to the troops. The commanding general of the department in the field retained award authority, and Meig's office in Washington reviewed and approved contracts after the fact. Errors detected were sent to the Secretary of War for resolution (19:220-222). As time passed, contractors were required to make explicit commitments on quantity, quality, and terms of delivery. Further, guaranty bonds were required on large contracts. Orders were frequently scattered because of regional business interests or political pressures. Many small and new firms proved unreliable or inadequate over time, and business migrated to larger firms. Price fluctuations of such magnitude occurred that long-term contracts were simply forbidden.

As the war widened, Meigs initiated a system of standing invitations to bid in order to discourage profiteers. This system allowed depot buyers to reject bids totally if they were unreasonable. It was also used to buy immediate needs, with future requirements delivered downstream (19:252). Meigs continuously objected to the burden imposed by the bureaucratic procedures and adamantly fought any further centralization of supply activities in Washington. He argued that responsible buyers and inspectors scattered throughout the country should be allowed due discretion in their activities but must also be held responsible for their actions (13:472-3).

One initiative Meigs implemented was hiring disabled cavalry officers as inspectors for horse/mule procurement. The horse situation had deteriorated so far that Meigs felt this was the only solution unless "Gen Burnside, under martial law, will hang one or two bogus or bribing contractors. That would improve the stock" (19:264). Meigs was concerned over the number of horses because he was also responsible for the fodder and transportation of that fodder. At one time, he questioned if there were not so many horses that they could not carry enough feed for themselves. When such is the case, Meigs asserted, every additional horse sent is a "candidate for starvation." Weigley draws a parallel to this situation in World War II when Army staffs had to recognize a limit on motorized vehicles in a division lest it be immobilized by its own fuel needs. Patton's armor, when it outran its supplies in 1944, did not need extra tanks (19:264).

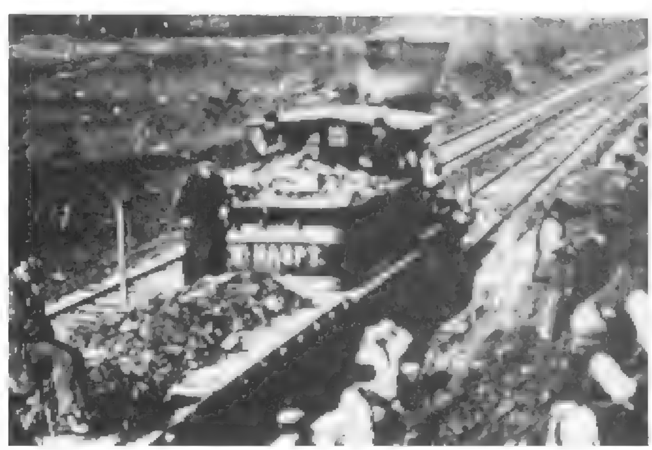
War of the Rails

The early war effort was hindered by a rapidly evolving but uncoordinated transportation network. The central government had always been one of noninterference. Just as there was no central banking or public health focus, transportation had received no direction from Washington. Incentives, however, in the form of land grant legislation and western land surveys, encouraged railroad growth (13:241).

There is little evidence of any advance consideration of potential value of railroads by either side prior to the onset of the hostilities. Although the rails were used very early to move troops to anticipated battles (Harper's Ferry, April 1861) and actual battles (First Bull Run), maximum advantage was never achieved until civilian rail management expertise was brought to the War Department. Two men chosen to do this were Thomas Scott (from the Pennsylvania Railroad) and Brigadier General Herman Haught, a civilian engineer commissioned to head the Union Military Railroads. Haught agonized over the seemingly hopeless task of educating subordinates about railroads. "We had more trouble from our own soldiers than the enemy," Haught said. Frequently, soldiers washing themselves and their clothes with a soap in springs and streams that supplied water to station tanks caused engines to stop on the road as boilers foamed over with soapy water (17:133).

The sheer magnitude of the war required rail use, repair, expansion, and protection. While some early creative thinking was evident (wounded returned from the front in deadheading rail cars), many obstacles prevented optimal use of the rails. The multiplicity of gauge was the single worst factor. Interminable delays were encountered at major terminals as cargo was offloaded from one line and reloaded on another because the cars themselves could not travel on the different gauge (17:44).

One feature of the existing rail network favored the Union in conducting the war. The predominant direction of Northern rail lines was east-west, which became a key factor in the Union Army's ability to move large quantities of men and materiel from theater to theater. The South, on the other hand, was hamstrung in that its western Confederacy rails were mostly



A vital supply line supporting the Army of the Potomac in Virginia.

north-south lines. Only one east-west line stretched beyond the Alleghenies, and it changed gauge on the eastern side of the mountains, hampering easy contact between large areas of the Confederacy.

Additionally, the amount of trackage favored the North, which had more than 21,000 miles of the 30,000 total miles available at the start of the war (17:31-32). The Northern roads were also constructed more heavily, and their yards had a much larger output capability, giving them much longer staying power in any protracted conflict (17:43).

It was inevitable that government dealings with the rails would become big business. Early in 1862, passenger and freight traffic was divided into four fixed-rate classes (13:301). The government tried to distribute traffic equally among lines, but rates initially published by the War Department were imprecise. It was never understood by the rail companies whether the published rates were *normal* or *maximum allowed*. Overcharges were found by the Van Wyck Commission as well as numerous examples of no competitive bids for service. This was a partial cause for the Railroad Act of 1862, which allowed government takeover of rails if the public safety required it. Implied in this was that inequitable or exorbitant rates were not in the interest of public safety. The railroads took the hint, and although passenger rates remained unchanged for the duration of the war, freight rates dropped far below commercial rates (19:237-238).

Extensive use of the rails was a necessity because of the large troop concentrations characteristic of the war. An early and hard lesson learned by Northern forces was the value of reliable lines of communication with sufficient capacity. In 1861, Union Brigadier General Lyon left the railhead at Rolla, Missouri, in pursuit of Confederate forces. He waited at Springfield for resupply, which did not come. Transport beyond Rolla was limited to poorly maintained wagon roads, and resupply efforts were still poorly organized at this point. Overconfident or desperate, General Lyon attacked a larger Confederate force at Wilson's Prairie and was soundly defeated. Thus ended the first campaign by a large Union force that dared march beyond its rail supply line (17:96-98; 12:43). Other plans and combat operations during the war were similarly influenced by logistics considerations.

The Anaconda Plan

In the earliest days of the war, General Scott recognized any hope the South had of winning was dependent upon its access to foreign markets. Quite simply, the Confederacy did not have the economic or industrial self-sufficiency to conduct the war. Scott reasoned that any means of hindering external resupply of the Confederacy would shorten the war. His plan, dubbed the Anaconda, was to strangle the South with a naval blockade and simultaneous military pressure from the north, the Mississippi River (a priority), and the Gulf and Atlantic coasts. The plan had logistical merit. In addition to drying up external sources, valuable time was bought to allow Union forces to better equip themselves and gain critical experience in organization. The Anaconda Plan would have worked even

T. S. C. Lowe reported positions of Confederate redoubts and rifle pits from one of seven balloons attached to the Army of the Potomac.

Airpower and its support tail. McClellan used aerial reconnaissance in the Peninsular Campaign. Balloon wagons of T. S. C. Lowe can be seen in the foreground.

better had the South's potential for early and effective operations been recognized. As it happened, Southern operations commenced prior to the final knot being tied and disrupted its implementation (13:151-152).

Logistics and Tactics

Combat operations were frequently influenced by logistical considerations. Three bloody battles between General Ulysses Grant and General Robert E. Lee in 1864 are traceable to a decision that was basically a question of supply. Grant was pursuing Lee in Virginia and wanted to intercept him before Lee gained sanctuary in Richmond. Starting at Culpepper, Grant had two options. He could go west toward the Blue Ridge, turn south, and march behind Lee, or he could go east and attempt to bypass the enemy through the thick woods east of Fredericksburg. Grant went with the second because easy water carriage up the Rappahannock and Rapidan Rivers solved his major problem—how to provide a supply line (20:106-107). In support of some 100,000 men, a wagon train

and ferry system took the place of rails, which were still Confederate controlled. Lee's assessment of the situation allowed him to counter Grant's move and resulted in bloody battles at The Wilderness, Spotsylvania, and Cold Harbor in rapid succession (17:337).

Sherman's March

Any discussion of Civil War operations and logistics would be incomplete without including General Sherman's campaign for Atlanta and the subsequent march to the sea at Savannah. These two operations are classic examples of logistics as targets in war and of the tradeoff between supply and mobility. As a logistics target, Atlanta was especially attractive. In the South, only Richmond was more important as a manufacturing center (12:193). Additionally, during the war, Atlanta had grown to become the key transportation hub between southern and eastern Confederate forces. As Sherman commenced operations against the city, it contained the last major rail link between the two Confederate theaters of operation. Recognizing that the "great question of the campaign was one of supply" (21:295), Sherman conducted his army's actions from that perspective. Extraordinary measures were taken to protect and enhance the capability of the only rail supply line from Chattanooga. As long as supply was ensured, Sherman advanced. He advanced in a series of flanking movements, which forced defenders to retreat without the necessity of pitched battles. Historians generally acknowledge this flanking tactic to be more successful than frontal assaults for two reasons. First, frontal assaults are costly to the victor, and second, a defeated force retiring upon its own lines of communication can more easily replenish itself with materiel and rear echelon troops (10:162).

Cognizant of the logistics limitations forced upon him as he advanced, Sherman probably had little choice of tactics. As he advanced over the tenuous rail link from Chattanooga, he continuously had to leave guards at points vulnerable to hostile cavalry interdiction. This single rail link was also physically limited in what it could carry. These two factors did not allow Sherman the luxury of conducting attrition warfare, because replenishment was unlikely.

In Atlanta, Sherman used the rail link to Chattanooga and captured provisions to build a self-sustaining fighting force for the march to Savannah. When adequate stocks of ammunition were on hand, Sherman cut the rail link, gathered his rear echelon troops, burned all military targets in Atlanta, and headed for Savannah with 100,000 troops and no supply line behind him. In order to do this, he resorted to the age-old method of foraging to support his food and fodder requirements. The time of year favored foraging, and the land was reasonably rich (18:134). Enemy forces were insufficient to create any major confrontation with subsequent high rate of ammo usage, which could thereby threaten Sherman's only weakness. As a result, Sherman's name lives as an example of a daring and successful military commander who challenged the odds and won a victory. At the time, perhaps only he realized the part that good logistics planning and execution contributed to his victory. He acknowledged, "The Atlanta campaign would simply have been quite impossible without the use of railroads" (13:301-302). However, his appreciation for logistics did not necessarily extend to logisticians of the day. On one occasion, he threatened a less than optimistic quartermaster, "If you don't have my army supplied, we'll eat your mules up, sir—eat your mules up" (21:300). Threats of similar context are not unfamiliar to logisticians today.

A Maturing Capability

Evolution of logistics during the Civil War is best illustrated by contrasting support offered to Union forces during the first Battle of Bull Run with that furnished to Sherman upon his arrival at Savannah. The former was a relatively simple task involving small numbers and short distances, yet it was done neither smoothly nor effectively. The latter involved water transport and coastal rail. Its execution, aided by the

(Continued on page 38)

Liddell Hart on Sherman

This was the first war between modern democracies, and Sherman saw very clearly that the resisting power of a democracy depends even more on the strength of the people's will than on the strength of its armies. His strategy was ably fitted to fulfill the primary aim of his grand strategy. His unchecked march through the heart of the South, destroying its resources, was the most effective way to create and spread a sense of helplessness that would undermine the will to continue the war.

The havoc that Sherman's march produced in the opponent's back areas left a legacy of bitterness in later years that has recoiled on Sherman's historical reputation. But it is questionable whether that bitterness or the impoverishment of the South would have been prolonged or grave if the peace settlement had not been dominated by the vindictiveness of the Northern extremists who gained the upper hand after Lincoln's assassination. For Sherman himself bore in mind the need of moderation in making peace. That was shown in the generous terms of the agreement he drafted for the surrender of Johnston's army—an offer for which he was violently denounced by the government in Washington. Moreover, he persistently pressed the importance, for the future of the forcibly reunited nation, of reconciling the conquered section by good treatment and helping its recovery.

B.H. Liddell Hart
Why Don't We Learn From History?

Vicksburg and Gettysberg: Logistical Dimensions

Two campaigns fought 120 years ago decisively influenced the outcome of the War Between the States. Both the Vicksburg and Gettysburg *campaigns* ended on the same day—4 July 1863—with a Union victory. In both, logistics played a decisive role.

Logistics of the Vicksburg Campaign

Many historians view the American Civil War as the nation's first modern war. Both the Union and Confederate armies employed products of the Industrial Revolution that had been converted to military applications. The railroad, steamship, telegraph, balloon, submarine, machinegun, and hospital riverboat are but a few examples of the technological advancements that typified the new logistics base. These and many more scientific and organizational innovations altered traditional concepts for conducting war.

Both Union and Confederate officers were greatly influenced by European military tradition and convention. As a result, theories in logistics services resembled the magazine concept popular in post-Napoleonic Europe. This system allowed armies to operate from fixed military supply depots, usually prepositioned before the campaign began. Depots were normally located along or connected to railway and river port terminals as well as major road networks and commercial centers. Forward bases supplied ammunition, issued rations and equipment, and provided medical care. Regimental supply base personnel and quartermaster officers exchanged orders and supplies using military wagon trains, post riders, and contract civilian teamsters. Such well-developed logistics services supported the field armies during most of the Civil War campaigns.

In two campaigns, however, the Union Army departed from the American version of the magazine system. General Grant's capture of Vicksburg, Mississippi, and General Sherman's famous march to the sea were two important exceptions to the standards of the day. Both Grant and Sherman were audacious and unorthodox in their decisions to separate the main army from supply bases, maintaining no lines of communication, and relying on the countryside for subsistence. Modern logisticians should find both campaigns professionally instructive as well as historically interesting.

General Sherman's move through Georgia and the Carolinas was a strategic maneuver designed to strangle the South economically and disrupt it sociopolitically. Although Sherman's campaign is interesting from the standpoint of strategy, General Grant's Vicksburg campaign provides more logistics lessons. It shows how major logistics concerns can influence decisions at the tactical operations level. As such, it is the more suitable for a brief review.

We should note, however, that although the focus here is on logistics, the campaign was also a remarkable strategic success, more devastating and decisive than Gettysburg. An expedition beset with presidential anxiety, resupply difficulties, and stagnant operations was transformed through good generalship into a stunning victory. Vicksburg was perhaps Grant's best campaign. His success there is directly attributable to his understanding of the Union Army's logistics posture and the ramifications of his decision.

The campaign to secure the Mississippi River for the North had been underway for several exasperating months. Federal forces that attempted to capture Vicksburg had met with failure each time. Consequently, operations were stalled and frustrated.

The terrain was a severely handicapped ground and river operation. The city's location on high bluffs afforded the Confederate defenders a distinct advantage. The Union Army was rendered practically immobile. Compounding this immobility, Confederate cavalry raided the Union supply depot at Holly Springs and destroyed or captured enormous amounts of stockpiled ordnance, foodstuffs, and general troop supply items. The raiders also interdicted Grant's rail connection between units in the field and depots in Tennessee and Kentucky.

In March 1863, Grant decided to regain the initiative by outflanking the Confederate river citadel and its protecting army under the command of General John Pemberton. His plan envisaged the main army marching south on the west side of the river, recrossing, maneuvering inland, and attacking from the east. To accomplish these ambitious objectives, Grant realized his maneuver plan would require enormous logistics preparation and entail great risk.

He knew that once the Union Army cut loose from its supply base and the river fleet, it was likely to overextend its line of communication. Grant also knew he must prevent General Pemberton from joining forces with General Johnston's army headquartered in Jackson. The combined Confederate Army could force Grant either to fight an open battle against an equal force or abandon the entire campaign. Grant weighed the advantages, disadvantages, and consequences. He decided to proceed.

Two corps, under McClernard and McPherson, marched south to Hard Times to await Flag Officer David Porter's river fleet. One corps, under Sherman, remained in position and feinted against positions near Vicksburg. The key element in this phase of the operation was the rendezvous with Porter's fleet.

The move overland was exceedingly laborious. The route was through wide, soft bottomlands crossed by swamps and marshes. The bayous, difficult enough for foot soldiers to cross, were all but impassable for vehicles. Grant moved without his baggage trains, hoping the Union fleet would survive the downriver move past the Confederate batteries guarding the river channel at Vicksburg.

Although Porter's flotilla experienced massive bombardment, it arrived at Hard Times with the much needed supplies and transport barges for the ferry operation. The Union

force of 41,000 men was transported across the Mississippi and landed at Bruinsburg. Grant then revealed the next phase of his unconventional and bold plan: he would strike into the interior of Mississippi. Grant believed success required speed and flexibility of action; he could not afford the encumbrance of a stretched and vulnerable line of communication.

He directed commissary and quartermaster officers to collect and prepare more than 100,000 pounds of foodstuffs (bacon, salt, coffee, sugar, flour, and hardtack) as well as ordnance and clothing. These items were to be loaded on wagons and staged initially at Grand Gulf, then moved as needed to support the advance elements of the main force moving inland. Supply officers at Grand Gulf were to fill all requisitions immediately and deliver them if needed.

Grant determined that only ammunition would require replenishment in large quantities during the move. To meet this contingency, all regimental wagons (two per regiment) were loaded exclusively with small arms ammunition. The enemy countryside would furnish the needed forage, subsistence, and wagons. In Grant's own words, Union troops were to carry "what rations of hard bread, coffee, and salt we can and make the country furnish the balance."

Initially, Grant moved without accompanying trains. His soldiers maintained about 2 days' rations and ammunition. Each night at bivouac, commandeered wagons delivered foraged foodstuffs to Grant's field kitchens. There, they were prepared and supplied to the quartermaster for distribution.

Moving swiftly, Grant placed his army between Vicksburg and Jackson. His advance elements captured the state capital, then maneuvered for the attack on Vicksburg. Neither rear guard action nor Confederate resistance at Champions Hill could arrest his unrelenting advance.

Grant's success can be attributed largely to his decision to abandon traditional resupply methods, logistically important for two reasons. First, it gave Grant the speed and freedom his army needed to march 200 miles, fight four successful battles, and encircle the enemy garrison at Vicksburg. By freeing his army from a long line of communication (probably anchored along the Mississippi River bank), he saved manpower since none would be needed to protect it. Moreover, he could maneuver more rapidly and was not confined to trafficable routes for vehicles. The compact force thus was able to live off the countryside.

Second, by deviating from the standard procedure used by Union generals, Grant was able to confuse and deceive General Pemberton. The Confederate commander unwisely split his force in an effort to find and destroy Grant's nonexistent line of communication, which he presumed to be located along the Big Black River. With Confederate forces so widely dispersed, Grant was able to concentrate quickly and deliver fatal attacks against bewildered defenders in localized engagements before Pemberton could counter the Federal advance. General Johnston's force was maneuvered out of any position from which a riposte could be launched.

By mid-May, Grant's grand maneuver was complete, and the investment of Vicksburg began in earnest. He reestablished his line of communication with the Union river fleet at Haynes Bluff. With supply channels intact, Union forces received reinforcements and provisions for the anticipated siege. The beleaguered fortress, threatened with starvation, succumbed to the inevitable on 4 July 1863.

The Vicksburg levee. With the Mississippi fully controlled by the North, the Confederacy's forces were cut off from the bulk of their stores and production capacity.

Grant achieved his objective by maneuver and deception. The significance of his brilliant preparation and foresight for logistics services in the Vicksburg campaign cannot be overemphasized. They were inseparable factors in his equally brilliant tactical plan and bold execution.

Logistics of the Gettysburg Campaign

Although the strategic effects of logistics during the Civil War are much discussed, the tactical effects are too often simplified by merely listing statistics or pointing out that the Confederate Army was ill fed and poorly equipped. However, the Confederate invasion of Pennsylvania provides an excellent study of both the tactical and strategic impact of logistics. The tactics of the invasion—which was itself logistically motivated—were severely limited by logistics capability.

After the defeat of General Joseph Hooker and the Army of the Potomac at Chancellorsville, Virginia, in April 1863, the Confederacy had four options: it could continue its defensive strategy under pressure on three fronts and an increasingly tight naval blockage; it could send one corps from General Robert E. Lee's Army of Northern Virginia via the Confederate rail system to reinforce General Joseph Johnston and possibly defeat the union siege of Vicksburg; it could send one corps from Lee to reinforce General Braxton Bragg in order to defeat the Army of the Cumberland and recapture Tennessee, thus threatening General Ulysses Grant's line of communication to Washington and possibly forcing his withdrawal from Vicksburg; or it could reinforce Lee to 100,000 men by drawing troops from other theaters and invade the North.

The last option—an invasion of the North—was selected by President Jefferson Davis and his cabinet, for it alone offered decisive results. A successful invasion into the rich farmlands

of Pennsylvania might ease the critical supply shortages of the Army of Northern Virginia, encourage European support for the Confederacy, and reduce the Northern will to continue the war in light of the Presidential elections scheduled the next year. Furthermore, Lee would not support any plan that jeopardized his beloved Virginia.

However, since Davis did not fully support the invasion, he would not authorize troop reinforcement or supply allocation for Lee's army to support an invasion. Lee's supply situation had so deteriorated that he was forced to import fodder from North Carolina. The situation would not improve without drastic administrative action. But the Quartermaster General of the Confederate Army answered Lee's demand for supplies by saying, "If General Lee wants supplies, let him seek them in Pennsylvania."

In selecting the fourth course of action, the Confederate government established general strategic objectives for the invasion. It was to obtain supplies, encourage European support, and reduce the Union's will to continue the war. Lee failed to translate the strategic objectives into tactical objectives, however. Except for a carefully prepared deception plan aimed at bypassing the Union Army of the Potomac, Lee seemed uncertain of his ultimate destination, whether to move north to Harrisburg or east to Baltimore.

In May 1863, the Confederate Army still faced the Union Army in the vicinity of Fredericksburg, Virginia. On 3 June, General James Longstreet began to move his 1st Corps westward, one division each day, followed by General Richard Ewell's 2d Corps. The 3d Corps under General A. P. Hill would remain in position to cover the movement of the Confederate forces. The plan was simple. The Confederate Army would make a wide sweep through the Shenandoah Valley around the Union Forces. General J. E. B. Stuart's cavalry would screen the movement, and Lee would be in Northern territory before Hooker realized it.

The deception plan was not as successful as it could have been. The Richmond press printed current accounts of Lee's preparations and movements. Furthermore, the flamboyant Stuart was far from subtle in withdrawing from Fredericksburg. Stuart was so elated at the size of his cavalry force that he heralded his movement west with a military review, complete with musicians and gun salutes, at Brandy Station on 5 June. The review drew the attention of Union patrols and spies and prompted a dawn attack by Union cavalry on 9 June. The attack, though repulsed, revealed that the Confederates were on the move. Stuart's poor judgment brought him extensive criticism in the Southern press.

If Lee were moving west, why didn't Hooker drive through Hill and capture Richmond, which was lightly defended by local forces? One reason was that Hooker had not yet replaced the horses and artillery he had lost at Chancellorsville. In addition, the expiration of enlistments was causing a major personnel turnover in the Army of the Potomac. Nevertheless, these problems should not have outweighed the golden opportunity laid before Hooker.

It would seem that the main reason was Hooker's lack of resolve. By this time, Hooker was a defeated man, Chancellorsville having destroyed his confidence. He repeatedly requested permission from the Army Chief of Staff, General Henry Halleck, to conduct tasks well within his authority. However, President Lincoln and General Halleck no longer exhibited confidence in him. Instead by urging him to take the initiative, they only reinforced his timidity.

By 7 June, Longstreet had assembled the 1st Corps near Culpepper Courthouse, and Ewell's 2d Corps was entering the Shenandoah. Upon being informed of Ewell's march, Hooker ordered the Army of the Potomac northward. Having marched nearly 100 miles in 8 days, Ewell attacked the Union garrison at Winchester on 13 June, capturing 4,000 prisoners, 23 artillery pieces, 300 horses, and vast amounts of supplies and munitions.

From 19 to 21 June, sharp cavalry clashes fully revealed Lee's intentions, yet Hooker continued to vacillate. By 26 June, the 1st and 2d Confederate Corps had crossed the Potomac River. On 25 June, Stuart, with three cavalry brigades, began his fateful ride between the Union Army and Washington, which would put him out of touch with Lee for 9 days.

As a consequence of Hooker's military decline, General George G. Meade was awakened at 3 a.m. on 28 June to be informed that he was the new commander of the Union Army of the Potomac.

In moving to Gettysburg, Lee's army would pause at Staunton to receive supplies that had been sent up from Richmond. Once north of Staunton, the army would live off the land, except for a limited amount of ordnance that would move by rail to Staunton and by wagon onward. At Staunton, Lee ordered his corps commander to return all unnecessary baggage to Richmond thereby increasing mobility and carrying capability for captured supplies.

Lee ordered his corps commanders to obtain all supplies, livestock, and food possible but demanded all procurements be controlled by the Quartermaster and Commissary Departments. By requiring all procurements to be handled by his logisticians, Lee hoped to increase accountability and ensure proper payments, for Lee would not tolerate marauding or unlawful seizures.

Even though Lee's intentions are still unclear, he was in a perfect position to duplicate Marlborough's tactics of roaming the enemy's countryside until it was cheaper for his adversary to sue for peace rather than continue to feed a large hostile force. The farmlands in that area offered Lee many avenues of march that would supply the needs of his army, and while his force was not large enough to lay siege to Washington or New York, it could defend itself on a field of its choosing.

Historians question why Lee concentrated his army in the Cashtown Gap area west of Gettysburg when tactically it was not to his advantage. The field favored the Union Army, which would approach from the southeast supported by an excellent road and rail line of communication. The ridge lines would provide excellent defensive positions for Union forces. The Confederate forage teams would have to move through the mountains west of the battlefield to supply the army, exposing the Southern line of supply to interdiction by Pennsylvania militia, which could block the passes.

Considering the tactical inadvisability of the location, we must assume that Lee chose this area not as a potential battlefield but as a convenient road junction at which to mass his widely dispersed forces. Meade was threatening the Southern lines of communication. By massing at Gettysburg, Lee hoped to offer a counterthreat to Baltimore, thus forcing Meade to move east away from Lee's supply line.

Lee was operating under the false assumption that the Army of the Potomac was farther south than it was and that the Army of Northern Virginia would have sufficient time to mass and then move to more advantageous ground before being offered combat. Lee's error on the Union position was a result of insufficient intelligence; he lacked the cavalry needed to adequately patrol and reconnoiter. In fact, Stuart had taken only three of the five cavalry brigades in the army, leaving the other two to screen the line of communication. More judicious use of these two brigades could have prevented Lee's costly assumption.

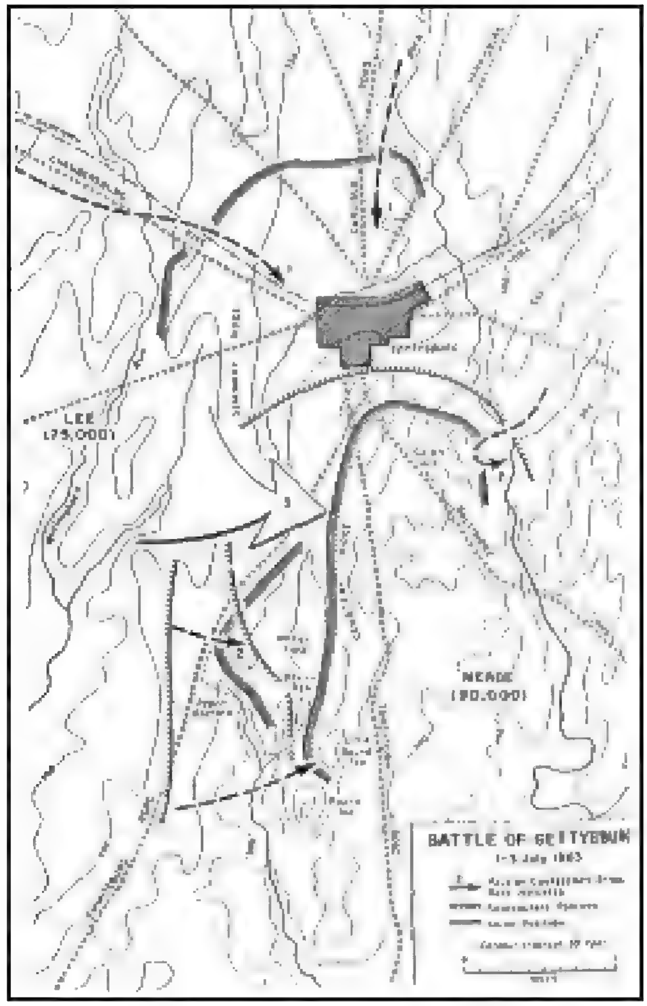
Soldiers of General Henry Heth's Confederate division approached Gettysburg on 30 June to capture a reported supply of shoes. Heth underestimated the strength of the Union cavalry occupying Gettysburg and attacked piecemeal early on 1 July. The tenacity of the defense by the two Union cavalry brigades entrenched on high round delayed Heth long enough for Union infantry to arrive, and thus Lee found himself engaged.

Lee hoped that Meade would take the offense but instead found the Union Army occupying defensive positions along Cemetery Ridge. As could be expected, the Pennsylvania Militia blocked the mountain passes to Lee's rear, limiting the effectiveness of his foraging parties. As a result, food in the Confederate Army began to run low in the second day of battle. Therefore, Lee chose the offensive rather than play a waiting game that heavily favored the North. Lee launched the costly frontal attacks on 2 and 3 July and, upon their failure, was forced to withdraw due to a shortage of ammunition and subsistence.

Lee might have withdrawn from Gettysburg to a more favorable battlefield as soon as he realized he faced the entire Union Army, but three considerations prevented him from doing so. First, moving his supply trains through the mountain passes would have been difficult and potentially costly. Second, retreating would further jeopardize his line of communication and negate some of the political gains already achieved. Furthermore, Lee still believed in the invincibility of the Army of Northern Virginia. He failed to recognize that the army had changed since Chancellorsville—General Thomas *Stonewall* Jackson was dead.

Lee's retreat was as precise as his advance had been sloppy. After realizing the failure of General George Pickett's charge, he immediately organized his forces to meet the expected counterattack. On 4 July, the army trains with the wounded were organized and sent along the northern route through Chambersburg. The remainder of the army held the position until darkness, then retreated south through Hagerstown.

The 2d and 3d Corps were on the ends of the column, with the 1st Corps in the middle escorting the prisoners. The lead corps would bivouac first each night, while the other two passed through it. Thus, the 1st Corps would remain in the middle, and the 2d and 3d Corps would alternate the lead and trail. Lee was careful to destroy the railroads along the route of his retreat to slow the Union pursuit.



The Battle of Gettysburg

Lee's army should have had little problem living off the land. The rich Shenandoah Valley and Pennsylvania farmlands had an average population of only 45 people a square mile, and in midsummer, a 6-month supply of food should have been readily available. The Army of Northern Virginia had a strength of 75,000 men, 5,000 of whom accompanied Stuart on his raid. Considering a linear distance of 90 miles from Winchester to York, Pennsylvania, 70,000 men had to subsist for 22 days (13 June to 4 July). That would require 190 square miles to be foraged, the equivalent of a strip 2 miles wide along the line of march.

Likewise, it would appear Lee would have little trouble feeding his army off the land during the retreat. After the battle, the Army of Northern Virginia had an approximate strength of 60,000 men. The retreat from Gettysburg took 10 days (5-14 July), which would require the supplies of 67 square miles.

Foraging during the advance was successful, but it was not so during the retreat. Even before Lee reached the Potomac

River, he had reported to Davis that, although his ordnance situation had improved, he needed subsistence.

Lee's food supplies were short for a number of reasons. One reason was that Lee's army retreated over the same route on which it had advanced. During the retreat, however, an additional 2-mile-wide strip was needed. This required the foraging teams to scout a wider area while still under pressure from Union cavalry.

Also, the local population obviously had evacuated, hidden, or destroyed some supplies to keep them from being captured by the Confederates. Confederate currency was practically worthless and offered no incentive for Northern farmers or merchants to sell their goods.

Captured supplies included grain, which might have provided food, but it first had to be milled into flour. This was not a problem during the advance, but during the retreat, the rivers were flooded, rendering the mills inoperable.

Finally, Lee did not have enough transportation to move extra supplies with his army. Although a considerable number of wagons and buggies were seized, many were loaded with wounded or ordnance, further reducing his ability to carry supplies.

The exact number of horses and wagons Lee had is unknown, but it can be roughly estimated. The army trains leaving Gettysburg occupied 17 miles of road. A standard supply wagon with team occupied approximately 40 feet of road. Assuming a gap of two wagon lengths between wagons (Union cavalry pressure and the haste retreat would compress the train), there were about 44 wagons per mile and 748 wagons in the trains. Lee's quartermaster, Lieutenant Colonel Corley, was put in charge of the trains accompanying the corps, which were in addition to the army trains. Assuming the number of wagons under Corley was as much as 25 percent of the number in the army trains, the total was less than 1,000.

Next to food and ammunition, fodder was the army's most critical need. A horse consumes more than 20 pounds of feed a day, and 1 acre of fodder would feed 50 horses for 1 day. Thus, the number of horses in Lee's army can be estimated at 16,000.

In addition to the number of horses in the cavalry, artillery and supply trains, and an unknown number of captured horses and cattle accompanied the army. Although claims files indicate that vast herds were seized, few seem to have reached Virginia, since severe shortages of food and horses were reported in the Army of Northern Virginia after the campaign was over.

The total forage required by the horses during the campaign was 10,240 acres or 16 square miles. Even if the number of livestock in the captured herds equaled the number originally in the army, it would seem that Lee's forage problems were minimal.

But this was not the case, for in a letter to Stuart on 9 July, Lee reported problems finding forage. This shortage can be at least partially attributed to:

- Lack of transportation to carry forage: 1 wagonload would feed only 400 horses for 1 day.
- Union cavalry pressure on the flanks of the columns where foraging and grazing would take place.
- The speed of the retreat, which would limit the time the animals could graze.
- The heavy rains during the retreat, which would beat down the grass and flood some grazing areas.
- The fact that some of the fodder had been carried off before the army's arrival.

Since Meade did not actively pursue, Lee was able to cross the Potomac River on 14 July 1863. His defeat erased the political gains of the invasion and was extremely costly in casualties—31,000 killed or wounded, including many important leaders. And the campaign did not erase the Confederacy's supply problems. Lee's troops wore out more shoes during the invasion than were captured, and many of the captured supplies were consumed or abandoned during the retreat.

His most significant loss was in horses. Many of the horses that returned to Virginia were worn out by disease, exhaustion, or malnutrition. The Army of Northern Virginia did not recover from these losses. Rather, Lee found his mobility degraded for the remainder of the war. The war was lost, though it was to last for 2 more years.

In retrospect, the Confederate decision to invade Pennsylvania seems sound simply for lack of a better option. President Davis and his cabinet can be faulted for ordering the invasion and then failing to support it with sufficient supplies and transportation. In their defense, however, one might argue that the supplies they could have authorized would have to be transferred from other theaters whose needs were also critical.

In the final analysis, Lee's chief failure was in not translating the broad strategic objectives into specific tactical objectives. Failing to establish tactical objectives, Lee became overly concerned about his line of communication. Since the supplies moving along it were insignificant, Lee could have better used the cavalry guarding it to keep tabs on Union forces and seek out caches of supplies. Better reconnaissance would have permitted Lee to continue to evade Meade's army and roam through the North or to accept battle on an advantageous field.

Major George M. Stephenson
Major Gilbert S. Harper III
Army Logistician, July-August 1983

The art of war is simple enough. Find out where your enemy is. Get at him as soon as you can. Strike at him as hard as you can and as often as you can and keep moving on.

Ulysses S. Grant

(Continued from page 32)

overwhelming industrial resources of the North, was virtually flawless. The number and variety of resupply items available to Sherman's forces were almost endless. The war witnessed a revolution in logistics capability, but most of the lessons would soon be forgotten as the war faded into history and US aversion to standing armies again visited itself upon the War Department.

Industrial Base

The war spurred technology growth and industrial activity. Coal and iron industries expanded significantly. Discovery of Pennsylvania oil in 1859 rapidly led to refinery operations in the northeast. Rail expansion provided a key dimension of the war's character. Invention of the mechanical reaper improved agricultural productivity. Elias Howe's sewing machine changed the face of the ready-made clothing industry, and an adaptation of that machine used to sew shoe uppers to soles contributed to founding the modern shoe industry (4:350). Lincoln himself encouraged technology innovations in armament, convinced of the North's superiority in mechanical arts and capability (3:ix).

Requirements

Requirements determination went from a *buy all you can find* charter during early phases of the war to a fairly sophisticated method of replenishment based on consumption and usage during later phases. The number of soldiers drove all requirements, from clothing and weapons to wagons and horses to carry them. Horses generated fodder requirements, which generated more wagon requirements until the law of diminishing returns began to take hold.

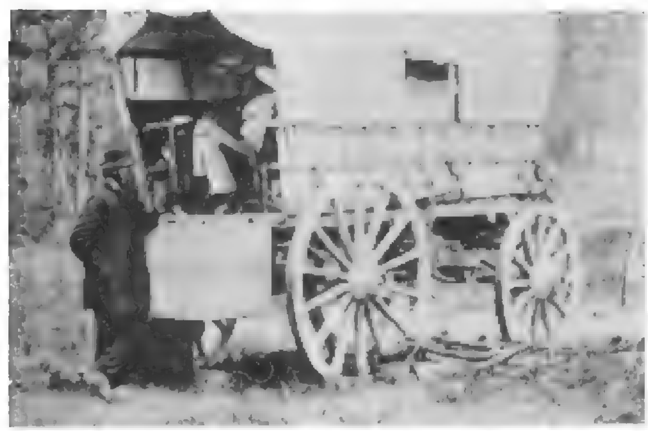
Acquisition

Acquisition practices did not change substantially during the war an, indeed, had many characteristics familiar to contemporary military contracting specialists. Buy American, buy from the low bidder, support small business, and other themes were well known to Civil War buyers. The telegraph was one innovation that enabled quicker buys over long distances. Lack of a centralized acquisition apparatus of any size hampered initial efforts to equip troops, who could be marshaled much quicker than their required support equipment. Uncoordinated efforts by many different buying levels hiked prices and opened the way for flagrant waste and abuse. Congressional actions somewhat curbed excesses but never eliminated them. War Department centralization of policy and oversight combined with decentralized execution of procurement actions ultimately became the accepted and workable combination.

Distribution

Distribution underwent dramatic change. The large armies demanded support in quantity. The railroads, just coming into their own, provided this capability and added the element of speed. Civilian rail experience brought into the War Department aided growth and application to military uses. Demands on the railroads spurred much earlier development of a coordinated national infrastructure and elimination of different gauges and interchange difficulties than otherwise would have been the case. While initial problems existed,

The *Daugherty wagon* was reserved for officers of high rank.



The *escort wagon* carried a standard load of 3,000 pounds and could handle up to 5,000 pounds in an emergency.

General McClellan's supply dump near Yorktown. This was a staging point for his advance toward Richmond.

Beans and Strategy

In 1863, there were 160,000 soldiers in the Army of the Potomac confronting General Lee's Confederates across the Rappahannock. This was an impressive aggregation, but its very size imposed difficulties, notably in providing a continuous supply of rations.

The Union Army was tied to its railhead supply points or the distance from those railheads that available horses and wagons could haul the necessary supplies. In addition, each soldier carried rations for 3 days in his pack. This meant that the Army of the Potomac could never undertake any strategic maneuver exceeding 3 days' march from its supply point, whether that was the railhead or the radius made possible by available wagons and teams. The Union supply problem vastly simplified General Lee's command problems, for he reasonably could anticipate that Union forces would not undertake any assault on his lines involving marching beyond their ration supply. As a consequence, he could concentrate his inferior numbers directly opposite the point of Union concentration.

The able and energetic Union Army Quartermaster General, Montgomery Meigs, perceived that there must be a way out of this strategic dilemma. One possible solution was to increase the number of wagons and teams used to link the railhead to the site of the troop concentration. General Meigs' calculations revealed that for every 100,000 soldiers some 1,400 wagons were required to haul supplies 2 miles from the railhead. To haul supplies no more than 4 miles from the railhead required 3,140 wagons, while to go 8 miles he needed 7,500 wagons. The difficulty, of course, lay in the fact that not only did the longer distance increase the turnaround time for each team employed but also each team consumed more fodder as the journey lengthened. More fodder required more wagons and so forth, in a dismaying geometric increase. It was evident to Meigs that he would be better served to seek an alternative solution.

Base camp, 1864.

Fortunately, General Meigs was an imaginative soldier. Sometime earlier, he had read in a French journal about experiments conducted with desiccated or concentrated vegetables for use as operational rations. Following up on this inspiration, he arranged to have rations developed that weighed somewhat less than the conventional 3-day rations but would feed a man for 8 days. This simple innovation abruptly extended the strategic mobility of the Union Army but made it possible to undertake wide end runs that would force General Lee out of his prepared entrenchment behind the Rappahannock. This opportunity to seize a strategic advantage was badly bungled by poor leadership on the part of the Union high command. But this bungling in no way diminishes the significance of the innovation introduced by the resourceful General Meigs, providing the lesson was heeded.

Dr I. B. Holley
Marigotta and Sanders, Technology, Strategy and National Security

distribution procedures and capabilities were, for the most part, effective over the duration of the war.

Maintenance

Maintenance actions were essentially contained at unit level. Northern industry became so prolific that Union forces developed very little in terms of a conservation ethic. Broken weapons were discarded; winter clothing was also discarded, usually with the first hints of spring, as foot soldiers lightened their loads. Horseshoeing and wagon repairs were done at unit level.

Indian Wars and Military Decay

Demobilization after the Civil War was geared to retaining sufficient administrative resources for Southern reconstruction efforts with Army emphasis again returning to the frontier mentality. Forces were committed to protecting the transcontinental rail efforts and the continuing westward movement of settlers.

Logisticians of this period were not confronted with significant challenges. The requirements and requisitioning procedures used in the Civil War were retained for the most part. A steadily improving transportation infrastructure, based especially on rails, became a key element in the Army's ability to easily support its widely scattered frontier forces and outposts. Commercial wagon networks to support local hauling grew up at the terminus of rails and at major interchange points. The Army itself kept its field transportation network (so laboriously born during the Civil War) intact until budget constraints and the lack of an Indian threat combined to bring its demise in 1895 (6:268). Huston also makes the point that a supply officer familiar with 1866 operations would not have

Civil War Reflection

Even today, fascinated by the strategy and tactics of the Confederate commander in Virginia, to oppose whom the North was never able to find a comparable military leader, students of the Civil War often devote themselves primarily to the 4-year struggle in the Old Dominion and to its occasional interludes in Maryland and Pennsylvania. There is no doubt that the war was fought primarily in this theater. But though it was fought so largely in the valleys of the Shenandoah, Potomac, Rappahannock, and the James, it was neither won nor lost in the land drained by these rivers. It was won and lost instead when control of the Mississippi fell into Union hands and the men and supplies of the three western Confederate states could no longer find their way to the armies that were fighting for the Confederacy—when a Union army, marching unopposed from captured Atlanta to the sea, destroyed every mile of railroad along its 60-mile-wide route through Georgia and broke the last connecting link between the supplies and people of the deep South and the principal armies that were still in the field.

Hawthorne Daniel
For Want of a Nail

Louis C. Hunter, in *Steamboats on the Western Rivers*, reported that water transports moved more than twice the amount of subsistence, ordnance, quartermaster, and medical stores as did the railroads. Capacity ranged from 250 to 1,700 tons. An ordinary steamboat could carry enough supplies on one trip to subsist an army of 40,000 men and 18,000 horses for nearly 2 days. This was the equal of five 10-car freight trains.

Civil War commissary boxcars.

Imminent Surrender

If the fall of Vicksburg and loss of the associated rail line were not enough to deal a deathblow to the South, Sherman's 1864 march from Chattanooga to Savannah surely was. Sherman, chasing the Rebel army of Johnston, did on an immensely greater scale what Grant had done in his campaign to capture Vicksburg. He marched deep into enemy territory, cut himself off from his own base of supplies, lived off the land and captured goods, and hopelessly disrupted the railroads and sources of supply of the South.

In this way, Sherman would cut off from both Hood in Tennessee and Lee in Virginia any hope of obtaining from Georgia, Alabama, Mississippi, or Florida supplies that their armies now so desperately needed.

After the loss of rail linkages from Vicksburg and Atlanta, the South's transport system was gone. Its supply system was without supplies. The end had come logistically even before General Lee acknowledged that fact strategically at Appomattox.

Lieutenant Colonel David C. Rutenberg
Lecture, Air Command and Staff College, 1985

The final dictum of history must be that whatever excellence Lee possessed as a strategist or as a tactician, he was the worst Quartermaster-General in history, and that, consequently, his strategy had no foundations, with the result that his tactics never once resulted in an overwhelming and decisive victory.

Major General J. C. Fuller

found substantial change if he revisited his outpost in 1891 (6:268).

Thus, the stage was set in remarkably familiar style for forthcoming hostilities with Spain. The Army of 25,000 was larger than its pre-Civil War strength but small in terms of the country and its population. It was purely a defensive force and suffered terribly from continued funding cuts from Congress.

The Great Adventure—War with Spain

Even as the talk of war with Spain increased, no significant preparatory actions were taken. The government tried to adopt a neutral stance, but public pressures became increasingly vocal in support of Cuban revolutionaries (7:92). Finally, the sinking of the *Maine*, by accident or design, became the catalyst (or excuse) which swayed the McKinley administration to action. War was declared 21 April 1898.

Very little preparation by the Army was in evidence. Partially to blame was interpretation of a prewar (March 1898) military appropriation bill, which gave the military authority to spend $50 million, but none for *offensive purposes* (1:8). The Army—particularly the Quartermaster, Subsistence, and Medical Bureaus—adhered to the guidance (1:11). The result was that nearly 45 days of valuable lead time were wasted by inactivity. It is interesting to note that, in true Navy style, that service pressed ahead obligating a large amount of the money without worrying about the defensive nature of the expense (16:149).

Also, an interesting example of congressionally directed system acquisition *stretch out* contributed to an inadequate coastal defense. The Endicott Board in 1885 approved a thorough system of armament and fortifications for coastal use. Unfortunately, feeble congressional funding slowed the program to the point where, in 1898, only about 7 percent of the authorized guns were in place. More weapons were available, but carriage manufacture lagged behind gun production. For ammo, the best case example showed only 20 rounds per gun on hand (1:10). As a result, available manufacturing plans were initially burdened with producing critical items that should have been stockpiled.

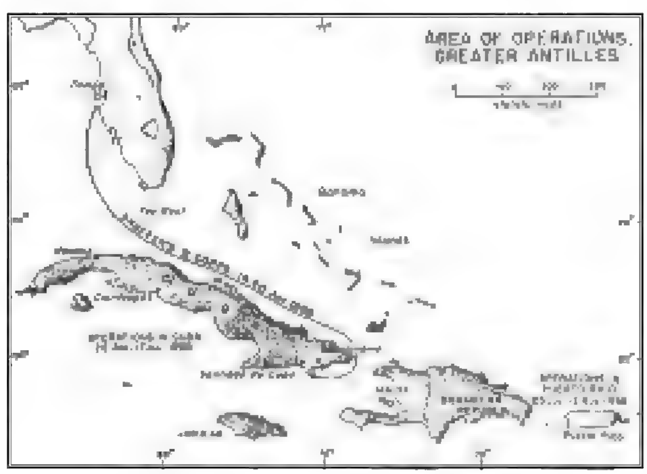
Administrative Bottlenecks

Army response was slow because the ten separate Bureaus of the War Department encouraged mountains of paperwork and slow decisions. Also, the official relationship between the Army Commanding General and the Secretary of War was fuzzy. While the Commanding General was intended to be the operations chief of all field units, in practice he and the Secretary acted as independent equals under the President. No general staff existed, and the bureaus tended toward parochial and uncoordinated actions (16:147). This then was the environment that logisticians were faced with as the call went out for volunteers to fight. Few stockpiles existed because of the confidence that diplomacy would settle the issue (16:161). Administration plans were unclear, so planners began contracting for requirements based upon their intelligence and best estimates. The initial call-up of 125,000 volunteers was not even coordinated with the Quartermaster or Chief of Ordnance (5:140).

Peacetime procedures and restraints to prevent fraud slowed progress. Contracts for all QM purchases still went through Washington for approval, even though this was merely rubber-stamp action (5:142). Congress eventually relented and gave discretionary purchasing power to levels below the Bureau chief (5:147). Congress also removed funding constraints in a grand fashion and granted immense amounts of money for the war once conflict was inevitable (24:23). Unfortunately, money could not buy lead time.

Specialized military items required longer lead times, thereby sometimes forcing acceptance of lower quality substitutes for the interim. For example, many of the unique six-mule army wagons had been disposed of when the army trains were disbanded in the mid-1890s. Since there was no civilian demand for them, few were kept available. When army orders dried up, the half dozen firms building these wagons reduced inventories of seasoned wood in proper sizes and shapes to zero. This forced substitution of lighter farm wagons that could not carry as much and broke earlier and more frequently (5:157). Additionally, no supply of military specification cotton duck for tents or khaki cloth for uniforms was available, and there were no facilities to produce them. True American ingenuity was displayed as the Post Office mail bag repair shop was recruited to help make tents from the cloth that was available (1:24).

The inadequacy of the field requisition system was nowhere better illustrated than when volunteers and federalized National Guard units began assembling at designated camps across the country. Supposedly, these volunteers would require only supplemental issue of items not furnished from state guard resources. Unfortunately, estimates of National Guard shortfalls, for a variety of reasons, were grossly underestimated by Bureau Regulars (24:94). The resultant flood of field requisitions inundated Washington and revalidated Murphy's Law. Behind from the start, depots directed shipments to camps and assembly points as rapidly as possible.



Unfortunately, political decisions for an early offensive resulted in many camps being emptied through relocation before the shipments arrived. This situation eventually led to establishment of a few large camps with depots. From these depots, supply officers began to fill most requisitions (5:165-166). Bulk quantities of new procurement were then shipped directly to these camp depots with no requisitions required (24:25). It is entirely possible that World War I procedures, whereby estimated requirements were followed by automatic distribution, would have been less wasteful and quicker.

Port Congestion

The domestic transportation network served the war effort well. Rail troop movements were cheaper, and accommodations were better than during the Civil War experience (24:28). The major snafu of the war centered around Tampa, the jumping-off point for the Cuban invasion. Poorly equipped to accommodate a large rail-to-ship interface, port congestion and confusion were intolerable. Rail cars were stacked up on sidings as far north as Savannah. Cars received at the port on the single line track from Tampa had no records of car contents or invoices. Bills of lading were weeks behind (1:66). Car contents were indiscriminately mixed so that units trying to link up with their support equipment often took the first supplies they encountered and, in turn, commandeered the first available ship for boarding. The results were predictable. Frequently, this unsystematic loading would find an artillery battery's horses and guns on one ship and their ammo on another (24:31).

In spite of these shortcomings, a formidable fighting force was assembled and loaded on ships for Cuba. There was no shortage of supplies—only a totally inadequate system of accountability. Hence, there was very little chance of necessary items being in the right place at the proper time.

Cuban debarkation (later in Puerto Rico and the Philippines) required initiative and a sense of adventure by an army untrained in landing operations. An insignificant number of lighters and small vessels were available, and this threatened the operation. The Navy, tasked by the Army for point-to-point transportation, graciously offered the use of its small craft and saved the day (16:213). Once ashore, resupply became the main problem as armed resistance was negligible. Troops took only personal equipment and some food ashore. As they moved away from shore, wagon support was desirable but lacking due to insufficient wagons and the state of the roads (more like paths). Eventually, the two landing areas at Siboney and Daiquiri became depots, and mule pack trains evolved to carry supplies forward (16:229; 5:212). The lack of transport capability, along with shortages in other auxiliary support (engineers and medical), could have resulted in a far different outcome had Spanish resistance been more determined.

Innovation

Technology contributed a major innovation in subsistence support. Refrigeration and canning processes eliminated the reliance upon *beef on the hoof*. Navy refrigerator ships supplied forces in all three invasions. The canned products, described by Theodore Roosevelt as *nauseating*, were less than enthusiastically welcomed by the rank and file (5:163-164). Smokeless powder was also being phased into service by the Army, but supplies were limited, especially for small arms. Most of the Spanish forces used smokeless powder and took advantage of the targets offered by unequipped US troops (24:94).

Changes were made in logistics support rather quickly after the Cuban invasion. On 18 July 1898, a separate transport division was established in the QM Bureau. Its two specialized branches were responsible for water transport and troop transport, evoking similarities to our modern single-manager transportation agencies. Fourteen large steamers were immediately bought to augment Navy and charter resources (5:218). Also, Tampa was abandoned in favor of ports further north in which larger ships could operate. Replenishment troops were eventually port called from camps to these ports only when transport was available (5:220-221). The Dodge Commission made additional recommendations in 1899 to separate supply and transportation, especially in the QM Bureau. A partial reason was complaints by other bureaus that the quartermaster, as sole manager for all transport, often shortchanged their supply movements in favor of its own when transportation became scarce. However, no merit to these charges was found by the Commission (24:44). The war was so short-lived that necessary changes to correct problems were seldom implemented. Huston points out that the 110 days available to the War Department were inadequate for later achievements to overshadow earlier deficiencies (6:288). Subsequent debates could not agree if the war demonstrated a need for reforms advocated by Emory Upton or proved that the existing system worked (5:312). Regardless, reform of the Army seemed inevitable and would become fact very early in the approaching 20th century.

Industrial Base

The relative weakness of the Spanish adversary contributed to the shortness of the war, but US resources were even more overpowering than expected. The availability of raw materials and the industrial ability to transform those materials put America in an enviable position. By 1900, Americans annually produced more than half the world's cotton, corn, copper, and oil; more than one-third of its steel, pig iron, and silver; and nearly a third of its coal and gold (15:33). Indeed, though, the wealth and capacity of the country made its total unpreparedness for an offensive war all the more inexcusable.

Requirements

The abrupt onset and quick closure of the war did little to encourage sophistication in this area. Again, planners and buyers were confronted with unknown force levels and destinations. Accordingly, requirements were based on guesswork and estimates. Uncoordinated efforts among the

Early Logistics Thinkers

In 1888, Lieutenant Charles C. Rogers, USN, introduced the subject of naval logistics at the Naval War College, just 4 years after the institution's founding. Since that time, the subject has had varying degrees of importance and emphasis in the curriculum. The nature of the subject, as it was studied there just prior to World War I, is illustrated by this quotation from a lecture presented by Commander C. T. Vogelgesang, USN, in 1911:

> Logistics comprehends all the operations conducted outside the field of battle and which lead up to it, it regulates the execution of those movements which in combination become the functions of strategy . . . .

Logistics had not yet regained the position of a new science of warfare accorded to it by Jomini. A bright spot did appear in a book written in 1917 by Lieutenant Colonel George C. Thorpe, a Marine and a graduate of the Naval War College. The book was called *Pure Logistics*, and in its preface, Thorpe resurrected Jomini:

> The terms *pure* and *applied* may be used with the same meaning as to Logistics as to other sciences. Pure Logistics is merely a scientific inquiry into the theory of Logistics—its scope and function in the Science of War, with a broad outline of its organization. Applied logistics rests upon the pure and concerns itself, in accordance with general principles, with the detailed manner of dividing labor in the logistical field in the preparation for war and in maintaining war during its duration.

Thorpe's influence was not immediately felt. In fact, many, continued to regard logistics solely in terms of its application. For example, Farrow revised his dictionary again in 1918 and in it offered a definition of logistics, which was succinct in comparison with its earlier work: "*Logistics*—That branch of the military art which embraces the details of moving and supplying armies."

Major General Graham Rider

Soldiers packed tightly en route to Cuba.

various bureaus were wasteful and inefficient. *Paper* assets supposedly in the hands of state National Guard units proved to be obsolete or nonexistent, placing additional burdens on early requirements.

Acquisition

There were no changes to dramatically alter previous Civil War practices. Purchases were still made based on requisitions from the field. Military specifications resulted in longer lead times for numerous items or use of substitutes of lesser quality or capability. Early stockpiling of consumables was needlessly delayed by vague wording in a military appropriation bill. Nevertheless, the acquisition process in place was adequate for the scope of war it supported.

Distribution

The domestic rail network was pervasive. Domestic distribution capability was limited only by paperwork and the ability to plan. During mobilization, field units moved before their supplies arrived. At Tampa, chaotic port conditions were caused as much by inexperience and time compression as any real constraints on the distribution network's ability to perform. In the overseas theaters, poor planning first limited the ability to move forces ashore, then to support those forces as they moved inland. Organizational changes in the War Department were made to clarify lines of responsibility, and other changes were recommended based on experiences in the war.

Maintenance

The brevity of the war precluded major activity in this aspect of logistics. Concepts were apparently unchanged from previous experience. Once moving, American industry did little to encourage a conservation ethic. Maintenance actions in the Army were primarily organizational in nature. No new large requirements existed, such as those that would follow the introduction of the combustion engine, to the battlefield.

The Logistics Burden

Logisticians are a sad, embittered race of people, very much in demand in war, who sink resentfully into obscurity in peace.

They deal only with facts but must work for men who traffic in theories. They emerge during war because war is very much fact.

They disappear in peace, because in peace, war is mostly theory.

The people who trade in theories and who employ logisticians in war and ignore them in peace are generals.

Logisticians hate generals.

Generals are a happily blessed race who radiate confidence and power. They feed only on ambrosia and drink only nectar.

In peace, they stride along confidently and can invade a world simply by sweeping their hands grandly over a map, pointing their fingers decisively up terrain corridors, and blocking defiles and obstacles with the sides of their arms.

In war, they must stride more slowly, because each general has a logistician riding on his back and he knows that, at any moment, the logistician may lean forward and whisper, "No, you can't do that!"

Generals fear logisticians in war, and in peace, generals try to forget logisticians.

Romping along beside generals are strategists and tacticians.

Logisticians despise strategists and tacticians.

Strategists and tacticians do not know about logisticians until they grow up to be generals—which they usually do—although sometimes generals will discipline errant strategists and tacticians by telling them about logisticians.

This sometimes gives strategists and tacticians nightmares, but deep down in their hearts they do not really believe the stories—especially if the general lets them have an occasional drink of his nectar.

Sometimes a logistician gets to be a general.

In such a case, he must associate with generals whom he hates. He has a retinue of strategists and tacticians whom he despises, and on his back is a logistician whom he fears.

That is why logisticians who become generals are a fearsome and frustrated group who wish they were anywhere else, beat their wives, get ulcers, and cannot eat their ambrosia.

Admiral Isaac Campbell Kidd, USN
First quoted in *Naval War College Review,* January-January 1983

Chapter Three

Early 20th Century Logistics

1900-1940

During the first 40 years of the 20th century, the world witnessed the great industrial revolution accelerating at an astounding pace. This revolution profoundly expanded the capability of nations to prosecute wars with total industrialized societies mobilized for conflict. In fact, in 1916, Naval Consulting Board member Howard W. Coffin stated, "Twentieth-century warfare demands that the blood of soldiers must be mingled with from three to five parts of the sweat of the men in the factories, mills, mines, and fields of the nation in arms" (6:309). New war strategies and tactics were developed to exploit these new industrial war-making machines. Logistics techniques also had to be developed to acquire, maintain, and move the massive quantities of raw materials and war goods produced by the nation. A full-spectrum of mobilization for warring countries was mandatory, for as Rear Admiral Henry E. Eccles states, "Logistics is that bridge between our national economy and the actual operations of our combat forces in the field" (23:42). In the 20th century, that bridge was to be called upon to carry awesome tonnage of materiel over greater distances than ever before attempted.

Effect of the Great Industrial Revolution

The first 15 years of the 20th century saw tremendous industrialization. However, due to organizational arrangements within the Department of the Army, the military logistics' capability to activate this new industrialization potential and use it effectively was severely limited. Criticism received by the War Department about its conduct of the 1898 Spanish-American War, together with the official findings of the commission investigating the conduct of the war, made it obvious reforms were needed (9:557).

Organizational Reforms

President McKinley's appointment of Elihu Root as Secretary of War led to crucial corrective actions. Taking office in August 1899, Secretary Root introduced two major bureau reforms that significantly altered the Army's support capabilities. The first of these was the establishment of the General Staff; the second was introduction of the *short detail system* (9:557). With no general staff, the Army bureau chiefs were totally independent and had not been coordinating with each other, leading to tremendous inefficiencies and poor support of troops during the Spanish-American War. In 1903, Congress enacted Secretary Root's proposal into law, created the Chief of Staff and the General Staff Corps, and abolished the separate office of the Commanding General Staff of the Army (9:558). The Chief of Staff and the General Staff Corps were responsible for coordinating the efforts of the bureaus and for long-range mobilizations and defense planning.

Congress also enacted legislation providing for a short detail system, which assigned line officers to a bureau for 4 years so that the bureaus could benefit from their current field experience (6:559). These changes were fundamentally important to the bureaus in that they were the genesis of integrated logistics support for our Armed Forces. The United States, as a colonial power, needed good logistics to support its overseas commitments.

New Mobility

At the conclusion of the Spanish-American War, the United States had become a colonial power by acquiring Puerto Rico, Hawaii, Guam, Cuba, and the Philippines. The United States also assumed the security of these possessions and needed the capability to project forces beyond its borders. It is interesting to note that the Army Transport Service was responsible for supplying these deployed forces and thus developed its own ocean transport, harbor boat service, and interisland service in the Philippines (9:567). With this capability, the United States was able to participate as part of an international coalition effort with forces from Japan, Russia, England, and France in quelling the Boxer Rebellion. In this effort, dubbed the China Relief Expedition, the United States moved 15,500 officers and men to China via the Army Transport Service. In fact, the 9th Infantry was in China only 19 days after receiving its initial orders in the Philippines (6:302-303). A unique feature of this transportation of men and supplies was its accomplishment practically without disease, injury, or loss of life (9:567).

Though this performance is not startling today, it was quite a contrast to the difficulties that had plagued the Quartermaster Bureau and Transport Service in 1898. In fact, primarily due to Secretary Root's *short detail system*, the Army Transport Service was able to transport almost three times as many troops as it did in 1898. The Transport Service was transporting a force of more than 70,000 troops (forces for Cuba, Puerto Rico,

Twelve-inch projectiles aboard the *USS Texas*.

and the Philippines) without accident, without complaint, and without nearly the anxiety, annoyance, and labor generated when it sent General William Shafter's army of only 17,000 to Cuba during the Spanish-American War in 1898 (39:567).

Debate: Who Manufactures Arms?

With the internal workings of the military smoothed out, a debate concerning military procurement policies erupted. The debate, centering around the military's role in armament production, began in the early years of this century and continues today. The basic question was, "Should the military make its own armaments, or should it rely on the private sector?" A discussion of the Navy shipbuilding program as it stood in 1905 highlights the pros and cons. The argument became particularly heated because the Navy had both of its government shipyards located in the South. One shipyard was located at Norfolk, Virginia, the other at Charleston, South Carolina. Shipbuilding had already reached a point where the quantity of capital, skills, and materiel had reached such large proportions that a tremendous coordination effort was required to construct a ship. To keep this large investment viable, federal contracts were a necessity.

Thus, when Southern Congressmen banded together to expand the two shipyards using the arguments of "frugality, efficiency, and avoidance of greedy capitalists who have the government by the throat" and used federal funds to construct federally owned manufacturing and service complexes that employed federally salaried personnel to train and maintain a skilled labor force, the uproar from the private sector was thunderous (2:59). The icing on the cake came in 1905 when the Army went into the gunpowder business with the construction of the Picatinny Arsenal in New Jersey, notably constructed in the North (6:297). Businessmen saw the government not only taking business away from them but also playing partisan politics.

The Army also had other government-owned and operated facilities. Five major arsenals were built after the Civil War. These arsenals were located at Watertown, Watervliet, and Springfield, New York; Rock Island, Illinois; and Frankford, Pennsylvania (2:41). However, because congressional appropriations consistently fell far short of providing the support necessary for retooling and modernizing their operations, four of the five installations suffered chronically from obsolete equipment and rundown facilities (2:41). The Springfield Armory was the only exception because it produced the Springfield Model 1903 rifle for the entire Army (2:41). With all but one of its armories badly run down, the Army often questioned the wisdom of producing its own weapons. After all, the Ordnance Bureau relied on Colt, Remington, and Smith & Wesson for most of its small arms and munitions (2:77). Additionally, in those days, civilian technology was similar to military technology, and conversion from one to the other posed few problems for the civilian industries (25:77).

Thus, the military was under constant pressure because the private sector saw armories as competition and a loss of business and profit to their operations. They lobbied their congressional representatives heavily. The debate of private versus public manufacture of military armaments was not resolved to any degree until 1915. Aside from armaments question the government relied, with view exceptions, on civilian production capability for items having civilian as well as military functions and contracted for those items (25:40).

Fixed-Price Competition

Items for the military were procured by competitive bidding with the contract award going to the firm offering the lowest fixed price (25:41). Fixed-price contracts were used and financial advances (progress payments, in today's words) often, but not always, made as the work progressed. Dimensions, weight, and minimum performance characteristics were stated in detail in the contracts. Design was not fully stipulated, so contracts covered development as well as production (25:4041). In order to ensure a competitive bid, the Quartermaster Bureau pursued a policy of adapting its specifications for supplies and materials that were not significantly different from those available on the commercial market. This seemed to widen the competition and decrease the bids (9:590). Military aircraft began to be acquired on a fixed-price contract beginning in 1907 (25:42).

Military Requirements

During these early years, there was no formal methodology for developing requirements. However, certain forces external to the military did make some changes inevitable. For instance, in 1906, the Food and Drug Law was passed by Congress. A great interest in pure foods had prompted the public to become aware of nutrition and sanitation factors of food and food products. The basic ration for American soldiers had not changed since the Civil War and consisted of flour, meat, and beans. However, it now became a requirement that the following items be added: butter, lard, prunes, flavoring extract, cinnamon, and ground coffee (14:115). The Army faced the problem of moving food supplies in a volume never before required.

Military supplies in the United States were moved primarily by civilian railroads. In fact, 75 percent of the total US intercity

freight transport was done by train, and the military was highly dependent on this mode of transportation. However, the booming economy was growing much faster than the railroads, and recurring seasonal boxcar shortages were common. This situation was aggravated by the antipooling provisions of the Interstate Commerce Act as well as the vigorous enforcement of the Sherman Anti-Trust Act that made railroad cooperation difficult in matters of service as well as rates (17:27). Thus, tremendous inefficiencies were occurring, and the military's increasing volume of supply requirements was accentuating the problem.

The Credit System

In 1907, a significant military logistics improvement began to take shape with the appointment of Brigadier General James B. Aleshire as Quartermaster General of the Army. The significance of this appointment was that General Aleshire strongly believed in decentralized operations as the best way to achieve economies and efficiencies. He placed the whole quartermaster business of procuring supplies on a money-value basis and operated it in accordance with the principle of banking methods (9:590). Each chief quartermaster or quartermaster-in-charge of an independent station, public work, or other project was allotted sufficient credits to meet his needs. For instance, a post quartermaster ordered from a depot, through his chief quartermaster, supplies that were not to exceed the credit allotted for his post. The depot filled the order, sent an invoice showing cost, and received a draft from the Quartermaster General or a credit transfer for the value of goods. When the depot quartermaster needed to replenish his stock, the Quartermaster General cashed the draft by placing money to this credit.

This system placed on commanders and their chief quartermasters the responsibility for the proper and economical supply of their commands. It would give chief quartermasters and other quartermasters a degree of independence in meeting supply responsibilities, prevent the over-obligation of appropriated funds, curtail the accumulation of surplus stores at post, and lessen losses through deterioration of stocks remaining too long in storage (9:590-591). Each of the major Army depots procured its supplies independently through competitive fixed-cost bids and selected the lowest bidder. Thus, the entire Army procurement system was decentralized. The current base stock fund approach traces its beginnings to General Aleshire's decentralization.

Test and Evaluation

During 1912-1914, acquisition and requirement determination functions of the Army started getting motorized transport and the machinegun. In 1912, the Army sponsored a truck test on a course running from Washington DC, to Fort Benjamin Harrison, Indianapolis. The trucks covered this 1,524-mile distance in 48 days. Despite far from outstanding results, the test showed that trucks had some promise (6:298). Although the horse and wagon continued to be the Army's prime mover, the Army adopted standard specifications for a 1-1/2-ton truck, mostly because the Inspector General became convinced the time had come to develop military motor trucks (6:298). In reality, that was the requirement!

In 1913, Army test boards were looking for a replacement for the Gatling gun and tested the Menet-Mercie, Vickers, and Lewis machineguns. The board approved the Vickers machinegun, but nothing came of its recommendation. Meanwhile, the entire British Army adopted the Lewis machinegun in 1914 and found it to be extremely effective. Congress and the press joined together in questioning how an American invented machinegun came into prominent use in the British Army and yet was unacceptable to the US Army. The apparent reason for the rejection by the US Army was that the inventor had not brought his weapon directly to the Army but had taken it to a private company, which then offered it for sale (6:297). This meant that Army arsenals could not manufacture the weapon. So there seemed to be some constraints on Army testing boards that may not have been in the best interests of the country.

The Gatling gun first appeared in 1861 and was soon used by most of the world's armies.

Moving ammunition toward the front to feed the voracious appetites of Gatling guns at the siege of Santiago.

Adoption of the machinegun was to have a massive impact on logistics as it significantly increased the requirements for ammunition. This would later place a tremendous strain on the distribution system.

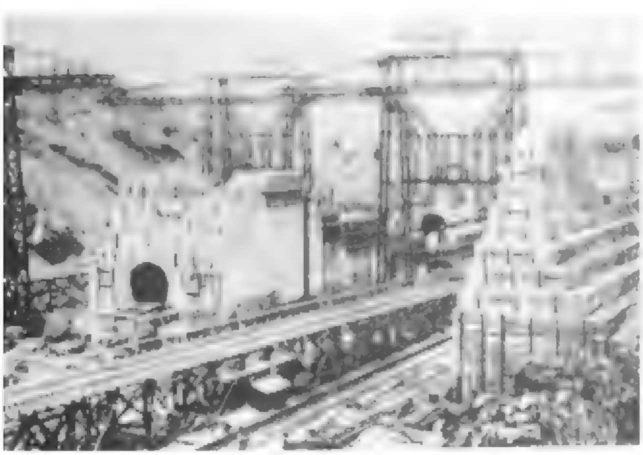
Following the Ordnance Bureau's lead in competitively testing machineguns, the Signal Corps conducted competitive tests for improved airplanes and airplane engines at its aviation center in San Diego, California (6:300). Unofficial experiments at College Park, Maryland, showed the feasibility of firing machineguns from aircraft. While this excited widespread public interest, the Army took no official notice (6:299).

These examples illustrate how the industrial revolution was progressing and how the military was unable to keep up with the capabilities that were available, because they had not yet determined the requirements for such capabilities. In the early 1900s, *private developments were driving military capabilities* instead of military requirements driving development.

Government-Industry Relations

Relationships between the military and the private industrial sector ranged from occasional close cooperation to hostile tolerance. However, a few people were beginning to realize economic preparedness was becoming the key to future military success on the battlefield. The US Chamber of Commerce was the vanguard of this principle. Since 1912, it had been advocating "government policed industrial self-regulation" (7:25). Such a philosophy was the inevitable result of the frequent abuses of private industries in their all-important quest for making a profit. Thus, a more formal relationship between the government and private industry began to emerge. In examining these relationships, the Army Chief of Staff informed the Secretary of War on 10 December 1915:

> . . . a board of the highest Army officers is unanimously and emphatically of the opinion that the government ought not to establish a monopoly in the production of any of its war materiel and ought not to manufacture its own war materiel to the exclusion of patronage of private manufacturers capable of aiding it (19:336).



Building a logistical shortcut—the Panama Canal's Pedro Miguel Locks under construction in July 1910.

This was the first official policy on the debate concerning private versus public manufacture of goods and supplies for the military. The basic policy was thus established that the Army would obtain its supplies from *private* manufacturers and would operate its own factories for the purpose of establishing standards, understanding costs of production, and ensuring that attention would be given to qualifying its officers as experts with respect to materiel needed. Such government factories would be limited to the manufacture of exclusively military materiel such as small arms, artillery, and ammunition (19:336-337). This policy, developed in 1915, is still the basic concept adhered to today. Adoption of this policy made it necessary to develop considerable cooperation between the military and industry.

The Navy took the first step in initiating the coordination process between the military and industry. In 1915, the Naval Consulting Board, composed of eminent scientists and inventors under the chairmanship of Charles Edison, was formed. The board established the Industrial Committee, which made an inventory of more than 18,000 industrial plans listing, describing, and classifying their capabilities for manufacture of war materiel (19:337). This effort was later to be the basic industrial mobilization plan used in World War I and World War II.

The first 15 years of the 20th century were dynamic and formative times for the US military establishment. The first real test of the military and its logistics infrastructure was to take place in 1916 against our southern neighbor—Mexico.

Mexican Punitive Expedition of 1916

The Mexican Punitive Expedition was not a large undertaking. However, the real significance to the United States of operations in Mexico was that they served as a *rehearsal and preparation for World War I.* For within less than a year, the United States would be called upon to undertake the greatest overseas expedition in history to help turn the tide in the world war that was raging in Europe (6:305). What was this expedition all about, and why did we undertake it?

In 1916, the army of General Francisco (Pancho) Villa was fighting against the federal troops of President Venustiano Carran for control of northern Mexico. The United States had good relations with the Carranza government, but Villa wanted to embarrass Carranza by conducting criminal acts along the border and inciting the United States to intervene (13:59).

On 11 January 1916, Villa's forces stopped a Mexican train in the northern Mexican state of Sonora and executed 16 Americans who were part of a mining engineer assistance group requested by the Carranza government. President Woodrow Wilson refused to be stampeded into intervention.

Finally, at 0400 on 9 March 1916, Villa led 1,500 Villistas in a raid on the US Army camp and New Mexico town of Columbus, killing soldiers and eight civilians. In response to the public outcry, President Wilson gained Carranza's permission to send a punitive expedition into the northern provinces of Mexico to capture or destroy Villa and his army (13:59-60).

On 10 March 1916, General John J. Pershing was directed to lead a force of almost 10,000 men into Mexico. By mid-April, Pershing's operations stretched as far south as Parral (400 miles from Columbus, New Mexico). The Mexican railroads proved to be unreliable. Good roads and good supplies were, therefore, to be the keys to success.

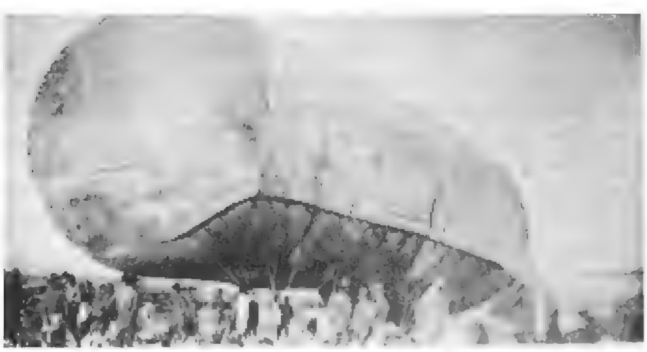
Lines of Communication

The main supply route was established and ran from Fort Bliss, Texas, to base depots at El Paso and Columbus, to the intermediate depot at Colonia Dublan, to the advanced depot at Namiquipa, and to another advanced depot at San Antonio. This chain of depots supported units on an area basis for rations, fodder, equipment, maintenance, remounts, and veterinary service (13:63). Thus the *lines of communication* (as the logistical distribution system was called) were established. Although the depots and main supply route ultimately provided for General Pershing's force, it took until the beginning of May before it was truly operational. Meanwhile, the bulk of Pershing's forces had reached Parral where he planned to conduct operations. However, because of a combination of local hostility and poor logistics, withdrawal was necessary. As Pershing reported:

> To supply such a force with the transportation then available would not have been an easy task. These rapidly moving columns had outrun the means of supply, and as there was neither food nor fodder obtainable in the district, withdrawal was the best solution to the problem (13:67).

Food and fodder presented the most serious logistical problems. Due to the kind of *maneuver war* that was being fought, actual troop locations changed rapidly, aggravating the already crippling lack of transportation equipment for movement from depots to the maneuvering forces.

Maneuver warfare often required the troops and their horses to live off the land or to purchase food and fodder locally after having outrun their supply lines. An interesting episode of the latter happened on 14 May 1916 when First Lieutenant George S. Patton and several other troopers set out in their car for Rubio to purchase food and fodder. Lieutenant Patton and his troops jumped a band of Villistas and killed three of them, including Colonel Cardenas, a member of Pancho Villa's staff.



An Ohio National Guard observation balloon prepares for patrol in the Mexican Border Expedition, 1916. This type of balloon was used to help direct artillery fire.

A US Army supply depot in Mexico.

The story is that Lieutenant Patton brought back the bodies of these three Villistas strapped like deer on the fenders of his automobile (13:67). Thus, logistics shortfalls sometimes brought operational successes even in a maneuver type of warfare.

Motorized Transport

Automobiles and trucks, instead of pack mules, were used for the first time by the Army in supplying troops. There were 17 truck companies commanded by army captains and manned by civilian chauffeurs and mechanics (13:65). However, the use of trucks had not been well thought out or integrated with the normal Army supply system. Spare parts were, therefore, difficult to obtain. Often, spare parts, as well as replacement vehicles, had to be ordered directly from the manufacturer.

Surprisingly, the quick response of the automobile manufacturers was impressive. For instance, within 22 hours of receiving an Army request for 27 armored trucks, the Packard Motor Company had the vehicles on their way by special train, complete with civilian chauffeur and a mechanic for each vehicle. The vehicles arrived in Columbus, New Mexico, 51 hours after leaving Detroit (13:65). General Pershing is credited with recognizing that the truck would become the most efficient method of transportation for the Army. Two recommendations made in the aftermath of the Mexican expeditions were to play an important role in the future of motorized supply. The first was that the Army should develop a *standard vehicle*. The second called for an *all-military unit* to operate and maintain trucks (13:65). But motorized transport was not the only innovation to be field tested in Mexico.

Airpower!

The 1st Aero Squadron

In April 1916, the 1st Aero Squadron was detailed out of Fort Sam Houston, San Antonio, Texas, to perform border patrol duties. This was the first airplane unit to serve with the US Army in combat. The unit performed daring reconnaissance missions until all eight of its aircraft were wrecked by the end of May 1916 (13:64). Although military people recognized the value of the airplane, its availability during combat was placed in question due to its high loss rates.

The final outcome of the Mexican expedition was inconclusive. Between May and September 1916, General Pershing consolidated his forces around Colonia Dublan, shortening his lines of communication and simplifying his logistics. Both Pershing and Pancho Villa then began a period of watchful waiting until 5 February 1917 when the last US Army unit withdrew across the border, ending the expedition. Thus, the US military had completed its first external operation using the initial fruits of the Industrial Revolution. But greater tests of the capabilities of this revolution, and the logistical means to provide those capabilities to distantly deployed fighting forces, were just around the corner.

The Great War

World War I or, as it was called at the time, *The Great War* represented the first time our country totally mobilized for war. The full impact of the Industrial Revolution on sustaining combat on distant continents was first felt during this war. It was the first war in which the United States fought external to continental borders and required economic mobilization on a grand scale. In this context, the logistics of waging wars changed significantly. To understand these changes, it is necessary to step back in time to the European theater prior to the American entry into the Great War.

Underpowered and ill-suited for high-altitude flight, American aircraft made a poor showing in Mexico. New Curtiss R-2s developed propeller trouble, and repairs kept them from seeing much service. As the Mexican Expedition came to a close, airpower hardly looked impressive, and a much more severe test lay only a year ahead for the 1st Aero Squadron.

An Air Service mobile machine shop in use during the Mexican Punitive Expedition.

The German Plan

In 1902 and 1903, the Germans considered themselves to be confronted by enemies on both borders. The French and the Russians were very hostile toward Germany as a result of years of warring and political fighting. The German High Command was tasked to develop a plan that would protect the territorial sovereignty of Germany. The High Command was, of course, deeply affected by the teaching of Karl von Clausewitz and the successes of his theories during the 1870s. Clausewitz's principles of surprise, speed, and seizing the initiative heavily influenced Graf Alfred von Schlieffen, Chief of the German General Staff, as he worked out the grand plan that was to be named after him. The Schlieffen Plan was essentially to take the initiative and *swing a hinge* by attacking through Holland, Belgium, and France while holding the Eastern Front in a defensive manner. After the hinge closed and the Western powers had been defeated, the entire weight of the German Army could be brought to bear on the Russians. The Schlieffen Plan was completed in 1905, and the German Army began to make preparations for war based on this plan.

Logistically, Schlieffen's plan was very ambitious in that the northernmost German Army would have to swing an arc of almost 400 miles before it reached Paris, and it had less than 40 days to do so (24:14-15; 10:109-122). To solve these logistical problems, Von Schlieffen simply wrote that the troops of the right wing would have to make "very great exertions" (10:116). As was typical, logistics took a backseat to strategy.

Schlieffen's plan was modified by his successor, General Helmuth von Moltke, to exclude a swing through The Netherlands. The Dutch had more than 90,000 troops and were highly regarded by the Germans. Von Moltke felt that it was politically and militarily wise to let Holland remain neutral in the upcoming conflict. Excluding Holland from the Schlieffen Plan required the northern First German Army to swing south and meet the German Second Army at the Belgium city of Liege before initiating the hinge action (10:109-122).

In 1914, General Alexander von Kluck was commanding the German Northern First Army, and General Karl von Bulow was commanding the German Second Army (24:15). On 3 August 1914, Von Kluck's First Army, with the Second Army on his left, crossed into Belgium and marched on Liege. By 17 August, Von Bulow had captured Liege, and Von Kluck had pinned the Belgian Army at Antwerp. The advancing German armies then increased their rate of advance from 5-8 miles a day to 8-1/2 to 13 miles a day. All of this was done on foot with animal-drawn guns as transport, backed up occasionally by what railroads were available. When deep into French territory, with the German Second Army just northeast

General Foulois' Logistical Roots

Many of the officers who served with the Materiel Division had outstanding military careers. For example, General Foulois was one of the first Army officers to operate the aircraft that the US Government bought from the Wright Brothers in 1908. He also accompanied Orville Wright on the final trial flight from Fort Myer to Alexandria, Virginia. In 1910, General Foulois was transferred to Fort Sam Houston, Texas, and placed in charge of the first Army airplane. Between May and July 1911, he designed and used the first radio receiving set to be placed in an Army airplane. In 1916, he participated in the Mexican Punitive Expedition with General John J. Pershing, and after being named Department Aeronautical Officer for the Southern Department at Fort Sam Houston, he took the first steps to establish the present-day Kelly AFB. Between March and September 1917, General Foulois was responsible for the production, maintenance, organization, and operation of all aeronautical materiel and personnel in the United States. Embarking for France in October 1917, he became responsible for all American materiel and personnel in France, the British Isles, and Italy. He became the Chief of the Air Service, American Expeditionary Force in November 17. General Foulois became the Assistant Chief of the Air Corps in December 1927 and Chief of the Materiel Division in June 1929. In May 1931, he commanded the Air Corps exercises, and this earned him the Mackay Trophy for that year. General Foulois became the Chief of the Air Corps in December 1931. He retired from active duty on 31 December 1935 after 37 years of service.

Logistics: An Illustrated History of AFLC and Its Antecedents, 1921-1981

of Paris, the French Fifth Army counterattacked Von Bulow ferociously. Von Bulow directed Von Kluck to divert from his wide arc and move eastward to help him. This maneuver caused the Germans to swing the hinge east of Paris, thereby allowing the French Sixth Army to attack Von Kluck's right flank. This action ultimately set up the Battle of the Marne, which halted the German advance on 5 September 1914 (24:16-17).

Logistics of the Marne

The crucial Battle of the Marne pitted Von Kluck's First Army, which was farther from its supply base than any other part of the German Army, against the French left wing, located right next to its lines of communication and base of supply in Paris. The resulting French advantage was exemplified at a key moment in the Battle of the Marne when General Joseph Gallieni, Military Governor of Paris, used the telephone to commandeer 1,200 taxicabs from the streets of Paris to rush one French Army division to the critical battle area (3:142-143).

Historians have postulated many reasons for the German defeat at the Battle of the Marne. These included the French reinforcement by taxicabs; a last minute change in German plans; toughness of the stand taken by the French General Joffre; and the separation of the German First Army from the Second Army, which opened a 30-mile gap in the front and allowed four British cavalry divisions to pour through and force the German First Army to retreat. These were the tactical events that affected the outcome of the battle, but the main reason for the defeat of the German First Army was simply that its *power had diminished as it moved farther from its base of supply*, while the French power had increased as troops retreated toward their base of supply at Paris (3:143).

A close look at specific items of supply illustrates how distance from their supply bases diminished the power of the German forces, particularly those of Von Kluck's First Army. Those items are fodder for the horses and ammunition for the weapons. It was very difficult for large quantities of animals to subsist off the land, but neither Von Schlieffen nor Moltke had made provisions for them, presumably because it was almost an unsolvable problem. The German Army was huge; Von Kluck's First Army alone had 84,000 horses to feed, requiring 2 million pounds of fodder per day. Clearly, any attempt to bring this much fodder up through German lines of communication (called *Etappen*) would have taken almost all of their transports (10:124). Consequently, it was often necessary to feed horses green corn, causing weakness and sickness. On 11 August, one cavalry division had to be taken out of the line because its horses were starving and exhausted. Two days later, all cavalry units in the First and Second Armies had to be rested for 4 days. By the time the Germans crossed the French border, all their horses were suffering from exhaustion and lack of fodder. The cavalry was incurring losses because their horses could not carry their riders away quickly—they were too weak. Finally, at the Battle of Marne, the German heavy artillery was prevented from being a decisive factor because its horses had been unable to keep up with advancing troops.

Thus, lack of fodder resupply ultimately deprived the Germans of their one qualitative advantage—their superior

Horses remained a key transportation resource despite the mechanization of war. A quarter of a million horses and mules provided motive power for US equipment and supplies.

The Wright Brother's Patent and Early Army Aviation

It is much more pleasant to go to Kitty Hawk for experiments than to worry over lawsuits.

Wilbur Wright,

In spite of one informal licensing arrangement that facilitated aircraft manufacture in the United States, *a patent jam* occurred that had begun to inhibit progress well before American entry into World War I. A *jam* is a situation in which the competing interests of adverse patent holders cause a halt in the development of the art and an inflation in the cost of the invention because of excessively high royalty demands. By 1914, the vast majority of the practical inventions used in heavier-than-air flight were in the hands of the Wrights' or the Curtiss' interests. Eventually, the government was instrumental in obtaining the formation of a patent pool, known as the Manufacturer's Aircraft Association. Established in October 1917, this association was controlled by three voting trustees. One of the trustees was appointed jointly by the Wright and Curtiss' interests, and one was appointed by the National Advisory Committee on Aeronautics. Revised and redrafted in 1928, the patent pool, represented by the Manufacturer's Aircraft Association, became a permanent part of American aviation financing.

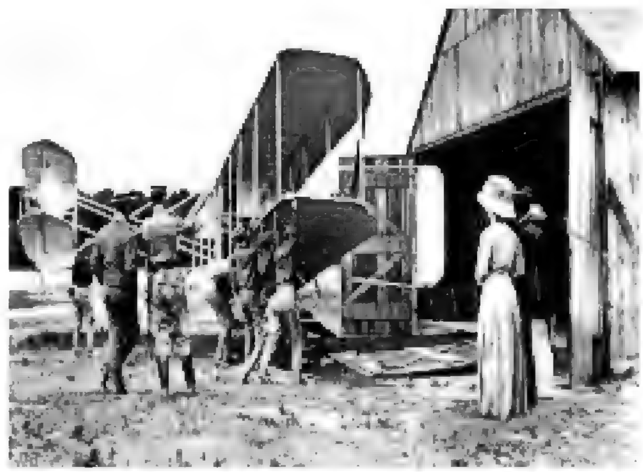
As a vital part of postwar American aviation, the patent pool represented a major achievement for the War Department and the US Government. However, it represented a resolution of the patent litigation that came too late to save the United States from unpreparedness in the air from 1917 through November 1918. Consequently, we fought our war in the air with European-designed and built aircraft; the major American industrial contribution to Allied aeronautics in World War I was the Liberty engine used in slow observation aircraft.

The United States entered World War I shortly after the ill-starred performance of the 1st Aero Squadron in support of the 1916 Mexican Punitive Expedition. In a nutshell, the loss of every plane in the squadron within the first 3 months of flying demonstrated the inadequacy of American military airplanes—the Curtiss Jn-2s sent to Mexico were unable to gain enough altitude to fly over the Mexican mountain ranges. Aircraft propeller laminates warped in the heat of Mexican noonday sun and the cold desert nights. Logistically, there was inadequate planning for replacement and spare parts; tactically, there was too little appreciation for the limited capabilities of the antiquated *Jennies*. By way of contrast, it was in July 1916 that airpower played such a vital role in the Battle of the Somme and the Germans introduced the Fokker F-1 with machineguns, firing through the propeller orbit.

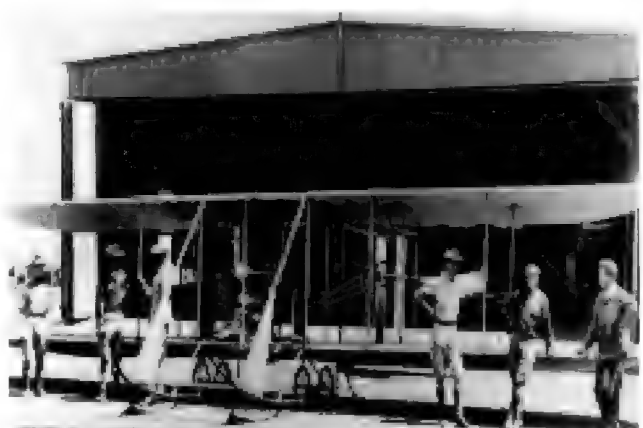
Why had European airplane design and construction moved so rapidly ahead of American capabilities? No doubt much credit is due to French, German, and British rearmament efforts and the increased demand for military aircraft of various types. Government orders sustained British and Continental airplane manufacturers, just as lack of US Government orders killed the initiative of American aircraft builders. The neglect of American Army aviation was also a product of general defense unpreparedness before the autumn of 1916; the largest proportion of the small defense budget went into construction of Navy dreadnoughts, our *first line of defense*.

Litigation over the Wright brothers' patent was certainly not the only cause of American aerial unpreparedness, but it cannot be dismissed as being of no consequence. Indeed, had the US Government secured a license from the Wright brothers in conjunction with its purchase of the military flyer in 1909, the history of military aviation might well have been substantially altered . . . .

Herbert A. Johnson
"The Wright Patent and Early Army Aviation"
Air Force Journal of Logistics, Spring 1985



Ground movement operations at the Wright Brothers hangar, Montgomery, Alabama.



The Army's second airplane at Fort Sam Houston. This ship replaced the first machine, which crashed during flight test, injuring Orville Wright.

World War I: Return of the Siege

In World War I, the very face of war was dramatically changed due to the new logistical demands of war machinery. For one thing, the more complex tools of war increased *consumption* of resources per man dramatically. The number of supply wagons per corps more than doubled, and artillery pieces increased fourfold.

Rapid-firing guns increased ammunition needs fantastically. In the Austrian war 40 years earlier, the Germans fired only 200 shells per gun for the *entire* war. In 1914, the 1,000 rounds per gun made available at the start of the war were gone in 1-1/2 months. As of World War I, *ammunition* replaced *food* as the dominant supply commodity. And ammo was not a commodity that could be foraged, requisitioned from local merchants, or purchased locally; it had to come from industry at home. Hence, the *whole nation* was now at war, not just the armies. Another new phenomenon was that the weapons themselves now had to be repaired or replaced. Previously, they had always lasted through the war.

These factors combined to create a curious result—the great increases in mobility expected from mechanization turned out instead to produce an immobile, *equipment-bound* force. In the words of Martin van Crevald:

> *The products of the machine—bullets, shells, fuel, sophisticated engineering materials—had finally superseded those of the field as the main items consumed by armies, with the result that warfare, this time shackled by immense networks of tangled umbilical cords, froze and turned into a process of mutual slaughter on a scale so vast as to stagger the imagination.*

The *tyranny of logistics* was never so strongly felt as on the muddy fields of World War I. Warfare had progressed from sieges to maneuver *back* to sieges, with logistics systems unable to support an army on the move, but only one *standing still.*

Lieutenant Colonel David C. Rutenberg
Lecture, Air Command and Staff College, 1985

heavy artillery pieces (10:125). Fodder proved to be a critical, yet completely ignored, factor in the Schlieffen Plan. The requirement for ammunition, on the other hand, was not overlooked in the plan. However, the quantity of ammunition required turned out to be vastly underestimated.

Ammunition resupply was carefully accounted for in the Schlieffen Plan, and hundreds of horse-drawn wagons were assigned to this resupply mission. Because of inadequate fodder, however, the horses could not keep up with the armies, so the whole ammunition resupply role fell on the few motor transport companies that had recently been formed. Ammunition was given first priority in the *Etappen*, but several factors prevented its timely arrival at the front lines. First, the motor transports were being taxed beyond their limits and often broke down with no spare parts available to repair them. Second, proper provisioning for gasoline had not been made. Third, the consumption rate of ammunition itself was grossly underestimated.

To further exacerbate the situation, General Seiger of the General Staff centrally controlled the supply of ammunition in Germany. Seiger would only relinquish his fast diminishing reserves at the last possible moment. General Groner, also of the General Staff, later wrote in his diary that in the future it would be necessary to give Army field commanders complete control over their own stores of ammunition, capsulizing a conceptual debate that continues to this day (10:126-127). At the conclusion of 1914, with the Schlieffen Plan stalled, the Germans and the Allies (French, British, and Belgians) were settling into trench warfare with its attendant *no-man's-land.*

American Advance Planning

Meanwhile, Americans were watching the war in Europe and publicly taking a stand of neutrality. During 1915 and 1916, the War Department and Navy Department were beginning to explore the *what if* of America's being drawn into the European conflict. General Pershing estimated if the United States entered the war 30 divisions (equivalent to 1 million men) would be required (6:311). Based on this requirement, the Army War College tasked the bureau chiefs for estimates of what would be needed. The Quartermaster General predicted that transportation equipment—including horses, mules, and motor transportation—could be obtained in 60 to 90 days, basic necessities could be purchased on the open market within 30 days, and other miscellaneous supplies could be obtained as rapidly as the Army expanded. Of course, these predictions proved to be ridiculously optimistic. The Ordnance Bureau reported more realistically that it would take a year to have enough rifles (Springfield Model 1903) for 1 million men. Additionally, they only had enough personal equipment for 200,000 men, horse equipment for a force of 63,000 men, rifles for 127,000 men, pistols for 165,000 men, .30-caliber ball cartridges for 146,000 men, and .45- caliber ball cartridges for 254,000 men.

The shortage of small arms ammunition was particularly critical. The Ordnance Bureau estimated that it would take 1 year for enough supplies for a force of 1 million to be produced after the funds were made available by Congress (19:230-231). This estimate, however, was conditional on the Ordnance

A well-equipped force mobilizes and trains for war.

Surprise and Fortification

How do the military and political leaders of a nation go about planning a strategy that achieves surprise? If surprise is a vital element in strategy, what were the French decision makers thinking when they decided to invest so large a portion of their resources in the Maginot Line? If they conceived of the line as a means of providing a secure base with a minimum of troops—to be able to concentrate their forces for some bold stroke, some startling initiative—then it might have been a sound investment.

Unfortunately, the Maginot Line not only absorbed a disproportionate share of the French defense budget but also, worse yet, seemed to stultify French strategic thinking. Once that massive investment in static defenses was made, it seemed, inexorably, to reinforce the defensive mentality of French generals and their planning staffs. In short, the sunk costs of the Maginot Line virtually dictated the contours of French strategy.

Dr I. B. Holley
In Margiotta and Sanders, *Technology, Strategy and National Security*

Bureau not having to compete with the Allies ordering from the same few manufacturers as did the Bureau. Similarly, the Medical Corps reported that it only had enough medical supplies to provide for the Regular Army (141,673 men), and it would take from 8 to 12 months to get enough supplies for 1 million men. Additionally, the Allies were already purchasing almost all the medical supplies and equipment available on the American market. The Corps of Engineers could fully equip the projected army, except for deficiencies in searchlights and pontoon bridge equipment. The Signal Corps stated that they could obtain most of their personnel and equipment from industry because of the similarity between Army and civilian equipment and operations. An important exception was aircraft. There were only a few aircraft in the inventory and practically no aircraft industry in the United States (19:230-234).

With these deficiencies reported to the Secretary of War, Chief of Staff, and Congress, the National Defense Act of 1916 was passed. The act authorized the formation of the Council of National Defense to be composed of the Secretaries of War, Navy, Agriculture, Interior, Commerce, and Labor. The Council established the Advisory Commission where the real work was done. The Council of National Defense and the Advisory Commission were civilian run. They initially defined the extent of the economic mobilization for war, clarified the ways it would be carried out under the Congressional Act of 1916, and resolved the tangle of relationships between the government and the private sector (19:337-339).

War was declared in April 1917, and the entire country began to mobilize its troops and resources and send them to France. The lines of communication for this effort were enormous. Lines of communications can always be described in three distinct parts: the *zone of interior, zone of communications,* and the *division area.* In World War I, our zone of communications included the ports in France and all the railroads, depots, and other types of transportation up to the division regulating station. Our division area included all the division's regulating stations, refilling and distribution points, regimental stations, battalion stations, and unit supply warehouses.

Supplies flowing through the lines of communication were categorized during World War I into four classes. Class I supplies consisted of rations, fodder, fuel, gasoline, and oil. Class 2 supplies included personal clothing, bedding, packs, and so forth. Class 3 supplies were all other authorized equipment for the units, including weapons, vehicles, rolling kitchens, axes, shovels, sanitary and hospital supplies, maintenance material, and so forth. Class 4 supplies were bulk items, including ammunition, construction material, and other special equipment (6:374).

In order to understand American logistics in World War I, what actually took place in each segment of the lines of communication, beginning with the zone of interior, must be reviewed.

Zone of Interior

In the United States, it was of paramount importance to transport all the necessary war materiel to the embarkation ports, primarily New York. The common method of transportation was the railroad since it was the only transportation system available that could handle the enormous quantities of men and materiel required. However, the inefficiencies of the railroads themselves—the government regulations governing them and the Army's decentralized system of procuring transport—created the worst freight car congestion the United States had ever known. President Wilson was driven to issue a proclamation whereby, through the Secretary of War, he assumed possession and took control of the nation's railroads under the authority of the National Defense Act of 1916 (17:29). The result was impressive. Federal control of the railroads fully relieved all the congestion without any significant net additions to plant or equipment. In fact, from January 1918 until the signing of the armistice, a total of 6,496,150 soldiers were transported, with 1,147,013 moved during July 1918 alone. During the entire period of mobilization and demobilization, 15,724,058 troops were transported. Also, the critical requirement for food transport to the Allies (1,160,000 tons per month) was met (17:29).

In addition to federalizing the railroads, the War Department reorganized itself several times, with its logistical activities ultimately becoming centralized. Centralization eliminated internal competition for manufacture and transportation, and this evolving reorganization helped the resupply effort considerably. Prior to centralization, bureau officers were in competition with each other and drove prices sky high, overloading existing facilities and causing war materiel to be shipped to ports indiscriminately. Ironically, the zeal of these determined officers—whose only concern was to do the best for their bureaus—was responsible for the paralysis of the

Without Logistical Planning

Even when the proper supplies reached France, it was exceedingly difficult to get them to the correct divisions. Colonel Johnson Hagood, placed in charge of the advance section of the supply service in the fall of 1917, encountered one frustration after another. The quartermaster of the 42d Division received word from the French that 900 horses were on the way, but no forage was available. The French informed Hagood that the shipment could not be stopped, so the quartermaster finally located some forage. Then the horses never arrived. The 26th Division received several packing cases addressed to a Boston department store containing quantities of baby clothes. "Trainloads of wagon bodies arrived in my area with no wheels," Hagood later remembered.

> The supplies of the 42d Division, at Vaucouleurs, were scattered out over a ten-acre field, most of it in the open and in such condition that it could neither be segregated nor used. This division had only six trucks to distribute troops and supplies over a billeting area of about eighteen square miles.

In desperation, Colonel Hagood, on 15 November 1917, addressed a memorandum to General Pershing's Chief of Staff, General Harbord:

> If the United States does not actually fail, its efficiency is certainly going to be tremendously decreased by the sheer incompetence of its line of communications, beginning in the US and ending at the French front. This incompetence applies not only to the machine as a whole but also, we may as well admit, to the individual officers and employees, none of whom has had experience in solving such a problem, In this, of course, I include myself.

American troops on their way to a training area in France.

transportation system during the 1917-1918 winter (2:83-84). General Aleshire's decentralized system worked in peacetime but was counterproductive in wartime.

An innovation that greatly alleviated congestion in US factories was the formation of the War Industries Board (WIB) in July 1917. The War Industries Board was subordinate to the Council of National Defense and was headed by famed industrialist Bernard Baruch. The WIB was formed to centrally procure military supplies by having the Army and Navy work together with industry. Prior to the formation of the War Industries Board, the Army and Navy were indiscriminately letting contracts, all with Priority 1 status. This only confused industrial production (19:340). The Army spent $14.5 billion between April 1916 and the end of the war. Pouring such huge sums of money into the economy through its antiquated supply system produced considerable havoc (7:31).

Competitive bidding and fixed-price contracting were required at the beginning of the war. The National Defense Act of 1916, however, empowered certain officials such as the Secretary of War, Secretary of Navy, and so forth to place contracts without formal advertising. In fact, the act allowed those officials to fix prices and, when producers refused the arrangement, to commandeer their plants and operate them (25:42). Voluntary economic mobilization did not progress in this atmosphere. The formation of the WIB, wherein civilian industrial experts voluntarily donated their talents as public officials without surrendering their positions or incomes as private citizens, set an important precedent in American military-industrial cooperation (7:27). When President Wilson appointed Bernard Baruch, he also made the War Industries Board a separate operating agency with real enforcement powers. President Wilson's appointment letter specifically enumerated the following tasks of the War Industries Board

- The creation of new facilities and, if necessary, the opening up of new or additional sources of supply.
- The conversion of existing facilities, where needed, to new uses.
- The studious conservation of resources and facilities by scientific, commercial, and industrial economics.
- Advice to the several purchasing agencies of the government with regard to the prices to be paid.
- The determination, wherever necessary, of priorities of production and of delivery and of the proportions of any given article to be made immediately accessible to the several purchasing agencies when the supply of the article is insufficient, either temporarily or permanently.
- The making of purchases for the Allies (19:340).

The WIB was ultimately organized into 157 commodity committees and more than 300 war materiel committees to organize and control the private sector of the country's economy (7:34). Although the committees were made up primarily of civilian industrialists who knew their respective industries very well, each committee had at least one Army or Navy officer assigned. Thus, the War Industries Board symbolized and, in fact, formalized the beginning of a government-industry partnership for the purpose of national security.

In 1917, a unique event occurred in this relationship. Some 200 builders and contractors came to Washington to consult with the WIB on the best way to construct new camps and cantonments. It was decided that the best way to get the job

done would be on the basis of contracts allowing for payment of costs plus a percentage of the costs as profit (6:318). Thus, the *first cost-plus-a-percent-of-costs contract* was adopted and was thereafter used extensively.

While the cost-plus principle overcame the disadvantages of the fixed-cost contract, no one was blind to the possibilities for waste. Precautions were necessary, maximum fees were often stipulated, sometimes sliding scale percentages were used so the fee increased in less than direct proportion to the cost, and bonuses sometimes were provided for cost decreases (25:43).

During the early war years, aviation was beginning to receive some attention. Logistical supplies required for aviation were initially controlled in Washington under the Signal Corps. On 24 May 1918, the Division of Military Aeronautics was created and organized to handle the functions of supply, finance, traffic, storage, materiel, construction, salvage, and engine and airplane maintenance and repair (20:27). Under the Division of Military Aeronautics, aviation facilities grew considerably. Aviation repair depots were located at:

Montgomery, Alabama	Middletown, Pennsylvania
Americus, Georgia	Dallas, Texas
Indianapolis, Indiana	San Antonio, Texas
Fairfield, Ohio	Richmond, Virginia (20:32)

The problems of logistics within the continental United States (CONUS) were enormous, but the problems of *transporting* all this materiel over the rest of the zone of interior (the Atlantic Ocean) provided a more than significant challenge. Just as the United States had been inexperienced in wartime control of the railroads, so it was inexperienced in controlling shipping for its wartime requirements (17:30). In 1917, German submarine sinkings of Allied ships reached a critical level. Almost 80 percent of all Allied oil was being supplied by the United States (12:30). Minimizing shipping losses of this vital commodity and other war materiel was essential to winning the war.

The Navy operated its own ships for wartime control of sealanes and kept its forces supplied with Navy-owned and operated vessels. The Army supplied its forces with its own vessels. The Army Transport Service operated more than 200 ships in 1917 (9:568). They were used to ferry troops and carry supplies to the Army. Unlike the Navy, however, the Army had to depend on civilian crews whether the ships were Army owned or chartered. Not unreasonably, Congress would not authorize the Army to commission any of its officers or enlisted men to operate vessels. When the war broke out, trouble with the civilian crews arose. Seamen left the Army ships and took higher paying jobs on other vessels. At critical times, they refused to sail until they were given wage increases. And the civilian crews were less exact in their discipline when convoying, which led to increased ship losses (6:352).

Finally, in September 1917, when no crew could be found for an Army ship that was loaded and scheduled to join a convoy, the Navy produced a crew from its own ranks. After this happened several more times, the Army entered into an agreement whereby the Navy would furnish crews and operate all troop, cargo, and animal ships for the Army. This was the first time the Army had entrusted the feeding and transporting of its men to another agency. On 9 January 1918, the Naval Overseas Transportation Service (NOTS) was established to operate all military cargo and troop vessels and recruit and train crews for them (6:352-353).

The problem of outfitting and supplying NOTS ships was a large order. But the NOTS organization rapidly solved the problem by decentralizing its procurement practices. As each ship came into New York, it was assigned a NOTS contact *officer* who would stay with the ship during the entire time in port and ensure that all requisitions for supplies were processed rapidly through the Navy supply representatives. He also ensured that other essentials were not overlooked. If the required supplies were not available through Navy supply before the ship was to sail, the contact officers were authorized to procure provisions locally. The task of supplying a great fleet of ships averaging 40 to 50 ships in port at any one time was not a small one, but contact officers acting as supply and procurement officers provided characteristically prompt and efficient service (1:37-38). This innovation was important to the US being able to solve most of the logistical problems of moving the American Expeditionary Force and all of its required supplies and keeping it resupplied through the zone of interior.

Zone of Communications

On 8 June 1917, General Pershing and his staff arrived in Liverpool, England. One of the first tasks the AEF Commander had to undertake was to deciding where to locate his lines of communication within the zone of communications. Avoiding ports where French and British shipping were already overtaxing the facilities ruled out the ideal harbors of LaHavre and Brest. Taking into account where the Americans would be fighting, where the American headquarters was to be located, where the AEF would train, and where facilities were available, General Pershing arrived at several alternatives in southern France. He decided to develop a system of *base*, *intermediate*, and *advanced depots* for storage and distribution of supplies. Therefore, on 21 June 1917, he designated Saint-Nazaire as Base Port #1 and Bordeaux as Base Port #2. Gievres and Chateauroux were designated as intermediate depots and Is-sur-Tille was designated as the AEF advanced depot (6:357). Later in the war, Marseille also became an important base depot for heavy equipment because of its deep-water port.

General Pershing established the AEF Headquarters at Chaumont. He felt very strongly about his lines of communication, both because of his experience in the Mexican Punitive Expedition and because of what had happened to the Germans in 1914. So when a serious proposal was afoot in Washington to detach the service of supply from AEF control and place it directly under the control of the War Department, Pershing grabbed for a pad on his desk, wrote "RUSH, RUSH, RUSH, RUSH" across the top and drafted a cable to the Secretary of War that said in part:

> The man who fights the armies must control their supply through subordinates responsible to him alone. The

Combat libations at a captured German canteen in Monsard.

responsibility is then fixed and the possibility of conflicting authority avoided. The military principle is vital and cannot be violated without inviting failure. . . . The Services of Supply and the lines of communication of our forces must be subordinate to the Commander-in-Chief. I very earnestly urge upon you Mr. Secretary that no variations of this principle be permitted (6:362).

General Pershing retained control of his lines of communication in France.

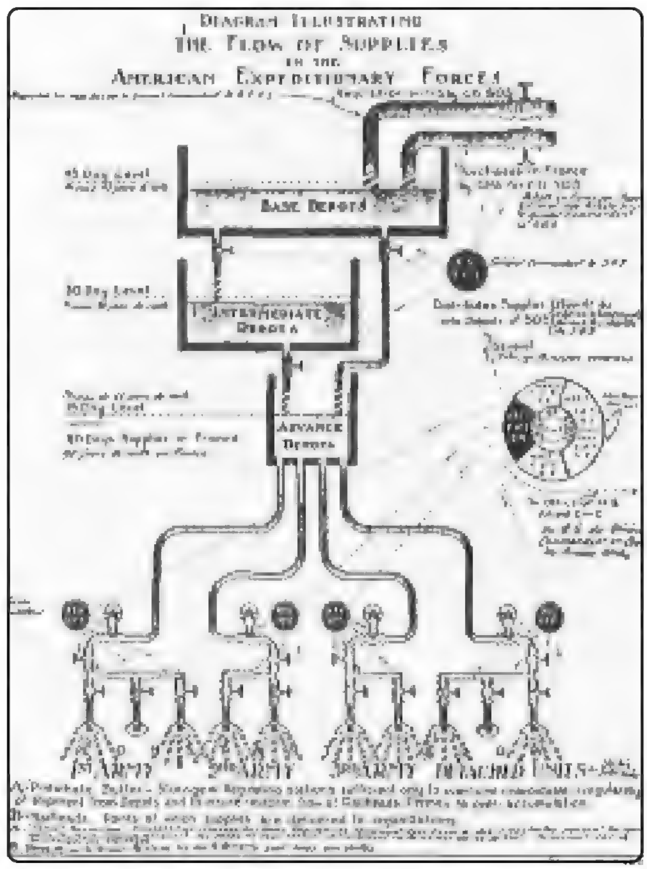
Within the zone of communications, the only form of transport that could move the quantity of troops and supplies required by the AEF was the railroads. The French, however, were completely overtaxed just in maintaining and operating their railroads for the British and themselves. So, when the Americans entered the war, they had to bring most of their own railroad troops and railroad equipment. During World War I, approximately 60,000 railway troops were sent to France (15:259). This figure included American troops engaged in railway construction as well as railway operations and maintenance. In fact, the Americans constructed 1,500 miles of railway tracks, numerous roundhouses, and 3,000 miles of telegraph, and telephone lines and built 15,000 locomotives.

A US Army canteen in France, circa 1918. All the typical, legal necessities were available—tobacco, matches, playing cards, candy, and gum.

Additionally, 20,000 freight cars were manufactured in the United States and shipped to France, and 83 ship berths had to be constructed at French ports. All in all, more than 650,000 men were engaged in sustaining this vast line of communication within the zone of communications. Of course, all such diversions of manpower and materiel to the logistics *tail* subtracted from the pool of available direct combat power available to the United States (3:150-151).

The Division Area

The last element of the lines of communication is the division area, which essentially ran from the advanced depot at Is-sur-Tille to the front lines. In the division area, transport was accomplished by horse-drawn wagons and, for the first time on a large-scale basis, by motorized trucks. Transport within the division area was under the direction of the division



commander; he allocated resources between his lines of communication and his combat units as he saw fit.

A significant help to the division commander was the automatic supply system implemented by HQ AEF General Order No. 73, dated 12 December 1917. The daily automatic resupply of a division was based on the actual strength of the division in men and animals. For the first time, an American army found a method by which food and all other Class I

(Continued on page 61)

Tribute to the SOS

Enormous supply lines slowly came into being as the American Expeditionary Force, finding that the French could not provide adequate ports or railroads or camps or warehouses, began building its own on a scale theretofore unprecedented. All this involved much manpower; Pershing estimated that of the first million men that arrived in France no more than 500,000 would be available for the front lines. Thus it was that hundreds of thousands of men found themselves assigned to the Services of Supply, filling vital needs but seldom seeing active combat. Major General James G. Harbord, who was in command of the SOS in the final months of the war, has paid tribute to the officers and enlisted men who filled its ranks:

> By far the great majority of the officers and men who wore the shoulder insignia of the SOS were fresh from civil pursuits. They came from every walk of American life and from every field of its business. The sacrifice at which they served could be measured by the energy and intelligence that they gave to their duties in the knowledge that the more they gave, the sooner the war would be ended. We were engaged in what was relatively a civil task, compared to combat. Far from the sounds of the drums and the guns; unsought by the glory-hunters; absent when promotions were being distributed; ineligible even at the price of life itself for the medals that reward heroism in action; doomed to spend the rest of their lives explaining why they served in the Services of Supply—their equal in trained intelligence and general fitness for their tasks could not have been found in any other land than the one for which they so truly fought. Such men may not have been within range of the enemy guns but they did more for their country by living for it than they could possibly have done by dying for it.

Major General James G. Harbord, Commander of the Services of Supply, with Brigadier General Charles G. Dawes, a leading Chicago banker and close friend of General John J. Pershing.

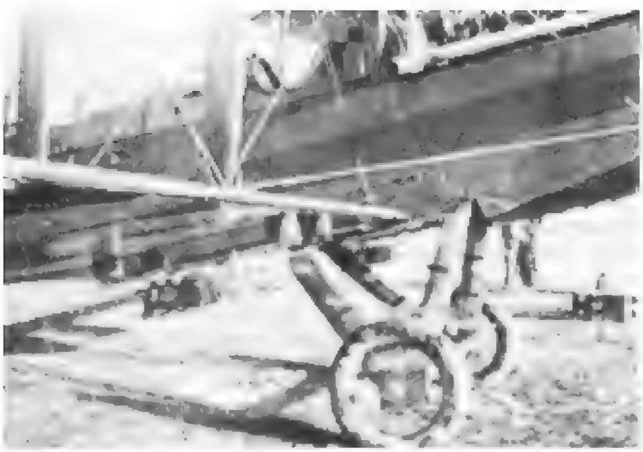
Pershing Nixes Rear Services

In February 1918, a board under Colonel Hagood devised a complete overhaul of the supply system. The Hagood Board proposed a new *Service of the Rear*—but since ribald soldiers might associate this title with latrine duty, General Pershing substituted the name Services of Supply. Throughout its existence, Hagood was the Chief of Staff of the SOS. The commanding officer until the end of July 1918 was General Francis J. Kernan. The sudden replacement of Kernan came as a *great shock* to Hagood, *since* he "had rendered most distinguished service." Pershing replaced him with Harbord, a combat general, in part to forestall a War Department plan to install General George W. Goethals, builder of the Panama Canal, in independent command over supplies.

Frank Friedel
Over There, 1964

World War I: Incubator of Air Logistics Concepts and Methods

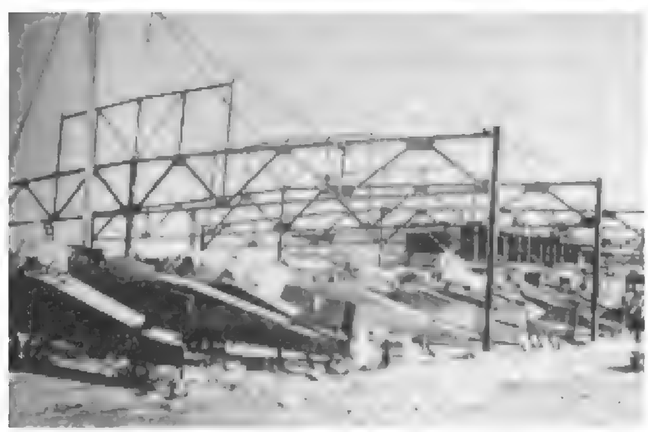
Maintenance verdict: replace one wheel, reshape the propeller, clean the windscreen. Lieutenant Elliot Springs, 184th Aero Squadron, crashlanded after an encounter with a German aircraft.



Field fixes on the DH-4: mud guards over the tires and bombs suspended in wire racks.

Pilots and mechanics of the 148th Aero Squadron performing engine runups before bombing German installations, August 1918. The airplane was unable to miraculously and quickly break the stalemated ground war as hoped. Brigadier General William"Billy" Mitchell viewed the Air Service's overall performance with satisfaction. The final box score: Americans shot down 927 German airplanes and balloons, while the Germans destroyed only 316 American airframes—a 3-to-1 ratio.

Munitions specialist practicing manual upload techniques under the watchful eye of a section chief. This is a Brequet bomber of the 96th Aero Squadron, Amanty, July 1918.



Aircraft were sometimes produced more quickly than fabrication hangars: circa 1916 at the Dayton-Wright firm building DH-4 trainers.

Brigadier General William Mitchell with the first Chief of the Army Air Corps, Major General Mason M. Patrick.

"I Also Had a Helper"

We arrived here on July 16th [1918] and were put to work repairing airoplanes, driving trucks, and so forth. I went into the erection and repair department as a rigger, but was put to work installing engines in the ships. Didn't stay at it long, however, as I started doing the soldering, brazing, welding (oxyacet), and so forth; anything, in fact, that came along. When we outgrew our hangar and moved into a double one, we built a shack outside for my special use. Had a forge and anvil, oxyacet outfit, two benches and lots of small tools (hammers, chisels, files, wrenches, screwdrivers, hand drill, and so forth). That was the start. I also had one helper.

Sergeant L. W. Felter
1st Air Depot, Colombey-les-Belles, quoted in
Freidel, *Over There.*

Repairing a damaged plane with the help of a field-fabricated alignment jig, Issoudun, March 1918.

Reporting Integrity, 1917

The history of 1914-1918 is full of examples. Passchendaele perhaps provides the most striking. It is clear from what Haig said beforehand that his motive was a desire to and belief he could win the war singlehanded in 1917 by a British offensive in Flanders before the Americans arrived. By the time he was ready to launch it, all the conditions had changed, and the chief French commanders expressed grave doubts. Yet, in his eagerness to persuade a reluctant British Cabinet to allow him to fulfill his dream, he disclosed none of the unfavorable facts that were known to him and exaggerated those that seemed favorable. When his offensive was launched on the last day of July, it failed completely on the part that was most vital. Yet he reported to London that the results were "most satisfactory." The weather broke that very day, and the offensive became bogged.

When the Prime Minister, becoming anxious at the mounting toll of casualties, went over to Flanders, Haig argued that the poor physique of the prisoners then being taken was proof that his offensive was reducing the German Army to exhaustion. When the Prime Minister asked to see one of the prisoner's cages, one of Haig's staff telephoned in advance to give instructions that "all able-bodied prisoners were to be removed from the corps cages" before his arrival. The chain of deception continued, and the offensive went on until 400,000 men had been sacrificed.

In later years, Haig was wont to argue in excuse that his offensive had been undertaken at the behest of the French and "the possibility of the French Army breaking up compelled me to go on attacking." But in his letters at the time, since revealed, he declared that its morale was "excellent." And the following spring, he blamed the government when his own army, thus brought to the verge of physical and moral exhaustion, failed to withstand the German offensive.

B. H. Liddell Hart
Why Don't We Learn from History?

The gilt chips off the glamor of soldiering pretty quick over here. Mail call and the quality of the mess become of deeper interest than the future of the world or who wears the crown of Courland . . . .

Lieutenant Howard V. O'Brien

An Airman Looks Ahead

A modern battleship, according to the old system of naval thought, may cost somewhere between $50 and $70 million. It may require, on an average, one cruiser costing between $20 and $30 million; four destroyers costing $3 or $4 million each; four submarines, a certain amount of airpower to protect it; and in addition to this, great stores for maintaining the personnel of more than a thousand men and dock yards and supply facilities to keep them up. So that every time a battleship is built, the nation constructing it is binding itself to about $100 million or more of expenditure and a certain amount per year to keep it up. Battleships have required heretofore complete replacement every few years to prevent their becoming obsolete.

As battleships and surface craft are helpless against aircraft unless they themselves are protected by airpower and as their influence on the destruction of seagoing trade is secondary to that of the submarines, nations are gradually abandoning battleship construction. Three are keeping it up: England, Japan, and the United States.

England is entirely dependent for existence on her seaborne trade; Japan, also, is dependent almost entirely on her seaborne trade. Where England and Japan would have to protect their commerce in the Seven Seas or starve, America could entirely dispense with her seagoing trade if she had to and continue to exist and defend herself. Where, therefore, a nation might have to expend a tremendous amount of effort and treasure on the maintenance of its seaborne trade at great distances from home, it would be better for one not so dependent on seaborne trade to put its national defense money and effort into active offensive equipment designed directly to defeat the enemy instead of dissipating its power in an indecisive theater.

The airman looks at the development of a country's military effort somewhat as follows. National defense consists roughly of four phases. First, the maintenance of domestic tranquility in the country itself so that the preparation of active fighting material can go on unhindered. An army on the ground to ensure tranquility and an air force in the air to prevent hostile air raids can take care of this. Second, the protection of the coasts and frontiers. An air force can do this and fight any hostile aircraft or destroy hostile warships while its home country is policed and protected on the ground by a land force. Third, the control of sea communications. This can be done by aircraft within its radius of action and otherwise by submarines. Surface craft have a secondary value for this. Fourth, the prosecution of offensive war across or beyond the seas. That may be carried out primarily under the protection of airpower, assisted by submarines and an army. A succession of land bases held by land troops must be occupied, and the enemy must be attacked directly through the air. Floating bases or aircraft carriers cannot compete with aircraft acting from land bases. So that, in the future, surface transports escorted by war vessels such as carried the American troops to Europe cannot exist in the face of a superior air force. Only when complete dominion of the air has been established can a war of invasion across the seas be prosecuted under present conditions. Airpower, therefore, has to be employed as a major instrument of war, no matter whether a land force or a sea force is acting on the surface of the earth.

William Mitchell, Assistant Chief of the Air Service
Winged Defense

(Continued from page 58)

supplies for an entire division could be delivered by merely telephoning a supply depot (4:69-71). This single invention by General Pershing's staff was the first time the American Army had ever been released from the bondage and slavery of requisitions for which the Quartermaster Corps had been so infamous. Combat-oriented innovations such as this allowed the logistical services of the American Army, particularly the Quartermaster Corps and Transportation Corps, to gain respect as part of the war effort.

To sum up the American logistical effort in World War I, the lines of communication provided the flow of supplies to the fighting units from a system of industrial mobilization in the United States. Ocean transport crossed the Atlantic. Base, intermediate, and advanced depots were established in France. Transport to the fighting units was by wagons and trucks. This flow of supplies was often pictured as a water pipeline with regulating valves.

The Interwar Years

From 1919 to 1939, the US military reflected on its logistical successes and problems during the Great War. Demobilization after the war was extensive, and because the *war to end all wars* had just been fought, only a small amount of the nation's resources were allocated to the military. The primary items of interest to the logistics community during this period were the advances being made in airpower and the ramifications of the National Defense Act of 1920.

Airpower Builds a Support System

During the closing days of the war, airplanes were used to evacuate the wounded from the battlefield. These airmen soon suggested that, if the airplane could be used to evacuate people, it might also be able to transport people and freight into the battle area. Due to the brevity of the US involvement in World War I, the airmen were really never able to test their concept (16:19). General Billy Mitchell proposed paradropping troops of the 1st Division behind enemy lines, and General Pershing approved the plan, but a change in the battlefield situation forced the project to be canceled (16:23). Very slowly, the seeds were being sown for air transport.

By the mid-1920s, a larger plane, the *bomber,* was being developed, and airmen began thinking in terms of strategic interdiction instead of tactical support to ground combat units. The introduction of large planes capable of carrying considerable weights opened the door to use of the airplane as a form of transportation. In 1932, Major H. J. Kerr proposed, in an Army War College study, that the Air Corps Materiel Division be enlarged to perform an air logistics function during war. He went so far as to propose that airpower could be used as air lines of communication to deliver all supplies and troops to air force units in the field (16:20). Although this proposal was the first time such a concept had been formalized, it was a reflection of the times.

In 1921, the Air Service had its depot structure reduced to four major depots called *air intermediate depots*. They were located at Fairfield, Ohio; Rockwell (San Diego), California; San Antonio, Texas; and Middletown, Pennsylvania. On 15 October 1926, when Congress abolished the Army Air Service and established the Army Air Corps, the Materiel Division took over the operation of these depots (21:3-4). The Air Materiel Division established the 1st Air Transport Group with four squadrons, each intended to serve one of the major air depots. The squadrons distributed spare parts to Army airbases (17:21). Since this routing could be viewed as a line of communication within the United States, Major Kerr's proposal no longer seemed quite so farfetched. It was, in fact, based on reality.

The Air Materiel Division of the Army Air Corps was a very progressive organization and made some significant changes. One involved the manner in which the Air Corps procured airplanes. The Air Corps was disillusioned by the tendency for winning aircraft designs to be altered substantially by the contractor during development. Thus, the Procurement Section of the Air Materiel Division abandoned paper design competitions in early 1930s and required full-scale flying *prototypes* to accompany the bid. The prototypes were meant to be built at the contractor's financial risk, but in practice, the Materiel Division purchased the prototypes that were submitted to allow the competing companies to recoup their investment and remain in business. Prototypes at that time cost as much as $600,000 each (25:44). This was the first time that full-scale prototype competition had been used, and it turned out to be a very efficient method of procuring equipment. Soon the rest of the Army was using this type of procurement.

The Procurement Section of the Materiel Division administered Air Corps contracts between 1928 and 1939 from three procurement district offices—Central, East, and West, located respectively in Dayton, Ohio; New York; and Santa Monica, California. Materiel Division plant representatives were retained at various manufacturers' plants. This type of centralized procurement with decentralized contract monitoring was another first invented by the Materiel Division (21:4).

The only major repair depot change during the interwar years was the movement of the Rockwell Depot to the Sacramento area (McClellan) in 1937. Repair depots were as big and diverse during the interwar years as they are today. In fact, the system of repair at a large depot was very similar to procedures used now. As the Air Corps Materiel Division's *Manual for Air Corps Supply* (1929) shows, familiar (if abbreviated) procedures were used for repair, overhaul, and remodeling of aircraft.

> (a) When an airplane, airship, or balloon is received for repair, remodeling, or overhaul, the Shop Supply Section will issue a work order request, to cover the work required.
>
> (b) Upon receipt of the approved work order request, the engineering officer will prepare a work order, determine the priority of the work ordered, and forward the prescribed copies in accordance with instructions.

Weapons and Doctrine—Lessons of War

Exactly what are the lessons to be derived from the experience of the United States with the air weapon during World War I? These lessons are much the same as those that might have been derived equally well from the Civil War or, for that matter, from any other war. As was true of former conflicts, World War I emphasized the necessity for a conscious recognition of the need for both superior weapons and doctrines to ensure maximum exploitation of their full potential. As a corollary to these two requirements, the war pointed up the need for administrative agencies to ensure their fulfillment once they have been recognized as requirements. The experience of the war showed clearly that wherever military authorities failed to emphasize the need for better weapons rather than more weapons they suffered serious disadvantage. Aerial warfare along the front proved that an enemy with fewer but superior weapons was fully capable of containing an opposing force with an impressive numerical predominance. Quality paid better dividends than quantity.

As a result of their neglect of doctrine, the air arm acquired no body of experience from which to derive an acceptable concept of aerial warfare.

The experience of the war also demonstrated that where military authorities failed to formulate a doctrine to exploit each innovation in weapons to the utmost they suffered further disadvantage. The example of bombing aircraft presented an outstanding instance of this neglect. Not only did the military authorities fail to get bombers into production for immediate use during the war, but as a result of their neglect of doctrine, the air arm acquired no body of experience from which to derive an acceptable concept of aerial warfare. Lacking such a concept or doctrine, the air arm had little to give authoritative direction to development of aircraft for the future.

Finally, the experience of the war showed that the failure to emphasize better weapons rather than more weapons and the failure to attach sufficient importance to the formulation of doctrine issued directly from inadequate organization. The war revealed that adequate organization fell into two general categories. The first of these involved organizations for information—that is, agencies for objective, systematic compilation (at all levels of operations) of facts and of facts, indeed, about aerial warfare and doctrines of airpower both foreign and domestic; facts regarding tactical developments to serve as a basis for countermeasures; facts about technical developments, about the result of proof tests and about scientific findings for possible application to weapons. The second of two categories or organization involved means for making decisions. The war showed the necessity of organizations at all echelons for making authoritative decisions based upon information systematically, objectively, and continuously accumulated by responsible and effective organizations especially created to gather data. At the same time, the events of the war showed that decisions based upon opinion, memory, a limited range of personal experience, or emotional bias led only to failure. There were the lessons of World War I, but did the air arm learn them?

I. B. Holley, Jr
Ideas and Weapons

Propellers being hand formed for the DH-4. Boards were laminated into blocks and then profiled into shape, yielding three props at a time.

(c) When the job is to be started, the foreman of the Airplane Repair Branch obtains the aircraft from the Shop Supply Section and enters the date the work is started on the original and quadruplicate copies of the work order. The original is returned to the administrative office and the quadruplicate retained for the foreman's reference.

(d) The aircraft will then be disassembled insofar as required for proper inspection and repair and, if necessary, thoroughly cleaned. The inspector will then thoroughly inspect all parts and assemblies. As parts or assemblies are found to be missing, damaged beyond repair, or classified as Class 2, they will be itemized on a parts shortage sheet. All removed Class I reparable parts and assemblies will be tagged with the reparable part routing tag and forwarded to the proper branch in accordance with the routing indicated. The routing prescribed will direct their return to the branch charged with the repair of the major assembly or if required in the final assembly of the aircraft to the Final Assembly Branch.

(e) Parts shortage sheets will be forwarded to the Shop Supply Section where the status of each article listed will be indicated thereon and the form returned to the foreman.

(f) All expendable parts, classified as Class 2, will be tagged with a reparable parts routing tag marked Class 2 and turned in to stock covered by a stores credit.

(g) All nonexpendable parts classified as Class 2 or damaged beyond repair will be turned in to stock and exchanged for like parts in serviceable condition.

(h) All expendable parts damaged beyond repair will be tagged with a condemned part tag and turned in to the Reclamation Unit.

(i) If the number of parts required in the repair of an aircraft is small and those parts are known to be on hand in the Shop Supply Section, the use of the parts shortage sheet may be eliminated and the parts required listed directly on the stores charge.

(j) If at anytime owing to a change in design or addition of new equipment or owing to a part having been overlooked in the disassembly of the aircraft it is desired to obtain new or additional parts, the foreman may prepare additional parts shortage sheets.

(k) The foreman of the Airplane Repair Branch will list all parts indicated on the parts shortage sheet as Class 2 by the Shop Supply Section on a stores charge; obtain these parts from the Shop Supply Section and forward them; properly tagged and routed, to the units charged with their repair. The parts indicated as on hand and serviceable on the parts shortage sheet by the Shop Supply Section will be obtained from the Shop Supply Section on stores charge as required. In case all items listed are not required by the Airplane Repair Branch, the parts shortage sheet will be forwarded to the Final Assembly Branch with the fuselage (envelope, car, and so forth) to provide a guide to the foreman of that branch for the withdrawal of the necessary parts for the completion of the aircraft.

(l) If at any time while the work is in progress a part or assembly is found to be unserviceable, it will be tagged with a reparable part routing tag by the foreman or with a condemned parts tag by the inspector. The procedure in this case is the same as that prescribed above for the repair or disposal of parts.

(Continued on page 67)

The engine repair shop at Fairfield in 1926.

Developing Aircraft Repair Policies

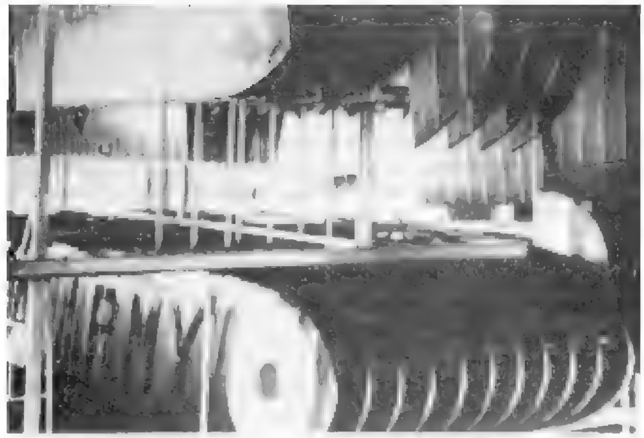
At various times, the Materiel Division attempted to establish a system of maintenance that would standardize the flow of work through the depots and improve the overall condition of aircraft and equipment. It made one of these attempts in 1930 when it called for all but two types of aircraft to be overhauled at 12-month intervals. Bombers and all-metal aircraft were not included under this policy. Bombers were to be overhauled every 224 months, and the all-metal airplanes were to be given an annual inspection at the depots and overhauled only when their condition warranted this action. The overhaul period for engines ranged from 125 to 200 hours.

The need for economy became acute in the early 1930s, and commanders were authorized to extend the service life of aircraft beyond the stated limits when they felt that flying safety would not be affected. In December 1936, the Materiel Division issued Technical Order 00-25-4, which stated that aircraft would be grounded for depot overhaul only when inspections disclosed the need for it and not because a predetermined period of time had elapsed. The technical order also indicated that aircraft were not to be completely disassembled and rebuilt if partial disassembly showed that there was no need for such extensive work. The technical order did, however, suggest certain minimum time intervals for the overhaul of aircraft and engines. One of the factors, in addition to economy, which led the Materiel Division to issue these new polices was the realization that, in general, the all-metal aircraft and new radial engines, which were beginning to replace the wood and fabric aircraft, required less attention. The policies outlined in Technical Order 00-25-4 remained in effect without any appreciable change until late 1939 when the overhaul intervals for almost every type of aircraft were stretched even more.

For a number of years, Air Corps aircraft were authorized a 5-year life as a standard or project equipment. In most cases, however, the aircraft were continued in service for an additional 18 months beyond the 5-year limit. The aircraft were generally salvaged for parts after 80 months of service and some types, such as primary trainers, were often kept in service for as long as 95 months. Occasionally, an aircraft was salvaged for parts before it reached its authorized lifespan. This usually occurred when an aircraft was damaged and the repair costs exceeded the allowable costs.

In February 1938, the Army Adjutant General ruled that obsolete aircraft should be continued in service until they were actually condemned. He specifically stated that pursuit, attack, and bombardment aircraft could be declared obsolete after 6 years, observation types after 8 years, and all other types after 10 years. The Materiel Division immediately changed all of its maintenance policies to conform to the new rules. The Air Corps took its first steps to change these rules in April 1939 when the Chief of the Air Corps, Major General Henry H. Arnold, recommended that the service life of combat aircraft be limited to 4 years for pursuit types, 5 years for medium and attack bombers, and 6 years for heavy bombers. General Arnold stated that the rate of obsolescence should be governed by tactical performance and new development and not by the endurance of a particular model.

Logistics: An Illustrated History of AFLC and Its Antecedents, 1921-1981.



Aircraft wings in storage at Rockwell Field, late 1920s.

We Americans had developed the best system of air fighting that the world had ever seen.

Brigadier General William Mitchell

Of Parts and Numbers—Tackling a Supply Nightmare

Major Augustine W. Robins, Commanding Officer of the Fairfield Air Intermediate Depot, poses with his staff in front of the headquarters building during the air races. (HQ AFLC Office of History)

The vast amounts of supplies that flowed into the depots after World War I created some serious record-keeping problems for the Air Service. In 1922, the supply officer at Fairfield reported that it had required more than 120,000 stock record cards just to list all of the materiel stored at the depot and the "tremendous labor of sorting, classifying, and storing this materiel consumed about two and one-half years, and it was not until the middle of 1921 that this depot could be said to be arranged according to any system or order." Some years later, in 1930, Major Augustine W. Robins, Commander of the Air Service, describes the state of records after World War I as follows:

> When I was Chief of the Property Division in Washington [about 1920], Mr. LaGuardia stood up on the floor of the House of Representatives and made a caustic speech criticizing the Air Service. He stated that the Air Service knew nothing about what supplies they had on hand and had no idea of the proper way to operate a Supply Division—which statement was absolutely correct. He then demanded that within six months the Chief of the Air Service be required to present to Congress a detailed list of all supplies, which were in possession of the Air Service. This was made in the form of a Resolution and presented to the President, who immediately directed the Chief of the Air Service to make up such a list and to turn it over to Congress. This nice little Resolution finally found itself on my desk. The buck having been passed thus far, I looked around for a little more passing to do to get rid of the paper, but found that it was impossible. A special force was organized, and Major Brett was brought in to compile a list of all the property in the Air Service. There wasn't a record that was worth the paper it was written on, so Major Brett told me as soon as he looked into the matter. I said, "All right, make up a list of all the supplies by guesswork." Within 6 months, a Liberty truck was backed up to the door of the Supply Offices . . . [and] loaded to the guards with records of supplies. This truck drove up to the entrance of the House of Representatives and the officer in charge, armed with the Congressional Resolution, informed the Clerk of the House that he . . . had the lists of supplies ready for delivery. The Clerk said, "All right, lay them on my desk." The officer in charge replied that there were too many to lay on the desk and that he had better come out, and when the Clerk went out and saw this truckload of typewritten sheets, he threw up his hands in horror and instructed the officer to dump them in a storage room in the cellar of the Capitol. This was done, and as far as I know, nobody has ever looked at them since. I remember clearly getting a request for information as to how many airplanes there were in the Air Service and having my office compile this information and at the same time send wires to every station in the Air Service requesting the number of airplanes at each station. The records of the office of the Chief of the Air Service and the records received from the telegrams were so far apart that any old answer would have been as good as any other.

The establishment of a property classification system was probably one of the most important steps taken by the Air Service after World War I. The system adopted by the Air Service was first worked out by Lieutenant Edwin Page during the winter of 1919-1920 when he was assigned to the Supply Division in the Office of the Chief of the Air Service. This system divided all equipment and supplies into 29 classes for the purpose of identification, storage, and issue. For example, Class 01 was used to identify airplanes and airplane parts; Class 02, engines and engine parts; and Class 03, airplane accessories. Later, the major property classes were broken down into subclasses. Thus, Class 01-A designated a complete airplane; Class 01-B, parts for airplanes manufactured by Consolidated; Class 01-D, parts for airplanes manufactured by Douglas; and Class 01-K, parts for airplanes manufactured by Martin. The same type of system was used for engines. For example, Class 02 referred to complete engines, while Class 02-D identified the parts for engines manufactured by the Wright Company. This system had to be modified in 1929 because tabulating machines for recording stock balance and consumption data were installed at Materiel Division headquarters and, later, at all the depots. Since the new machines could only record figures on the tabulating cards, two digit code numbers were substituted for the letter symbols. As new items came into the inventory, two additional digits were added to the original two. For example, the class code for all kinds of pumps was 48, while the number 4801 referred to a certain kind of pump produced by a specific manufacturer. In 1930, the Air Corps also began to use part numbers as an element of the stock number. Normally, the part numbers were assigned to a part by the manufacturer. In some cases, however, the depots manufactured a part in their shops and gave the part an Air Corps number.

Logistics: An Illustrated Account of AFLC and Its Antecedents, 1921-1981

Interwar Engines

The Liberty Engine

The Liberty engine was developed in the United States during World War I. Approximately half of the 32,000 engines produced in the United States between July 1917 and December 1918 were 12-cylinder Liberties, and only a small number were expended during the war. By 1924, the Liberty engine had undergone more than 200 modifications, and about 12,000 were still available for use by the Air Service. To reduce this surplus, the Air Service installed the Liberty on as many Army airplanes as possible, including the huge six-engine Barling bomber. A number of other changes, such as inverting and supercharging, were introduced later to modernize the engine and increase its power output. During the 1920s, the Liberty engine was required to undergo a complete overhaul after 50 hours of service. In 1930, the Air Corps lengthened the period between overhauls for the engine to 125 hours, and it authorized only four major overhauls to be performed on the engine during its service life. Major overhaul of the Liberty engine was finally forbidden in 1931.

Engine overhaul at North Island, site of one of the Army Air Service's first depot operations.

The process for overhauling the Liberty engine consisted of seven major steps. These were preparation, preliminary inspection, dismantling, cleaning and repair, final assembly, final assembly inspection, and testing. In the test phase, the engine was mounted on a test block and run for about 1-1/2 hours at speeds from 1,200 to 1,600 revolutions per minute.

Cleaning the engine was probably the most tedious operation in the entire overhaul process during the early 1920s, because all of the grease, carbon, and rust had to be scraped off by hand with the aid of only wire brushes and gasoline or kerosene. In 1926, however, the depot at Fairfield developed a new process for accomplishing the first rough cleaning. The cleaner consisted of a spray that contained a number of dissolved cleaning powders. Usually, one group of mechanics performed all of the steps in the overhaul process, although cleaning was usually assigned to the apprentices, and such machine shop work as reconditioning the cylinders was done by machinists who also made or reworked aircraft parts when required to do so. Specialization was not introduced into the engine shops until the 1930s.

Air-Cooled Propulsion Takes Over

The use of such liquid-cooled aircraft engines as the Liberty declined sharply after the early 1930s. If the manufacture of the British Rolls Royce engine by Packard during World War II were disregarded, only one liquid-cooled engine, the Allison, was developed and produced in the United States during the late 1930s. The Allison V-1710, however, was a very important engine since it powered such outstanding fighter aircraft as the P-38, P-39, P-40, P-51, and P-63 during World War II.

The Wright Corporation began to manufacture static radial air-cooled engines in 1920, and Pratt & Whitney and other manufacturers followed a short time later. The Wright *J* or *Whirlwind* series began to appear in the early 1920s. The J3 model, which appeared in 1923, was rated at 225 horsepower. The J5 was used in a number of famous airplanes, including Charles A. Lindbergh's *Spirit of St Louis*. The nine-cylinder Wright R1820 *Cyclone*, rated at 525 horsepower, went into production in 1927. This was the first version of the engine that powered the B-17 during World War II. A number of developments in the late 1920s and 1930s greatly increased the power output of the static radial engine. These included such improvements as the increased use of superchargers; counterbalancing the crankshaft using steel instead of aluminum for the crankcase; increasing the number of cylinders to 14 and, later, to 18; and using forged rather than cast cylinder heads.

The period between overhauls for various models of the Wright R1820 engine—a 14-cylinder model appeared in 1937 and an 18-cylinder one in 1939—ran from 300 to 375 hours. In general, the same seven-step process was used to overhaul both liquid-cooled and radial engines. By 1937, this process consisted of more than 60 separate operations. The inspection and repair of subassemblies was probably the most complex phase of the process. For example, the repair of cylinders and valves involved such steps as testing for leaks, deep valve seats, cracks, flaws, and wear and, if necessary, replacing worn valve guides, refacing valves and valve seats, grinding cylinders, lapping values to seats, connecting the valves and springs to the cylinders, assembling the camshafts, adjusting the clearances, and installing the cylinder covers.

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Global Logistics in 1925

Planning for the Air Service's around-the-world flight was probably one of the most striking achievements of the Property, Maintenance, and Cost Compilation Section and, after January 1924, the Field Service Section. The Property, Maintenance, and Cost Compilation Section began to work on the many supply problems that would be presented by the flight some 6 months before the four world cruisers departed from Seattle. After studying the problem, the section determined that climatic conditions made it possible to divide the world into six areas. A central supply depot was established in each of the six areas, and subsidiary depots were set up at various points between each of the larger depots. Supplies were sent to the depots by almost every available means of transportation, including sampans and canoes. Contracts were signed with various oil companies for gas and oil. The need to cover every emergency and make the supply system both efficient and economical led to the development of some ingenious ideas. For example, all the shipping crates were made of the same type of wood that was used in the airplanes so that any needed wood parts could be fabricated from the crates. The supply system was also very successful. During the flight, one of the airplanes experienced an engine failure, and a replacement was located only 100 miles away.

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(Continued from page 63)

(m) When the repair of the fuselage (envelope, car, and so forth) has been completed and work on other component parts of the aircraft has progressed to the point where it is ready for assembly, the fuselage (envelope, car, and so forth) will be forwarded to the Final Assembly Branch. The aircraft will then be assembled and inspected and the inspection and flight-test report prepared. If the aircraft is accepted by the test pilot, the inspector will attach a serviceable parts tag.

(n) When the job is completed and accepted, the foreman of the Final Assembly Branch will accomplish the foreman's progress report, indicating the date the job is completed and accepted.

(o) If the aircraft fails to pass inspection or the acceptance test and it is necessary to return any part to the Airplane Repair Branch, a reparable part routing tag will be attached stating the reasons for its return and the work required. The inspection and flight test report will be prepared in accordance with the instructions for the use of that form in such cases (18:90-95).

Progress in airpower was being made across the board, and the Materiel Division had made significant contributions. However, logistics as a whole was being relegated to its normal peacetime backseat position. The only national debate taking place concerning logistics centered on the National Defense Act of 1920.

Mobilization Planning: A Catch 22

The National Defense Act of 1920 directed the War Department to plan for not only its own operations for economic mobilization but also the entire nation's economy during wartime. The reason Congress tasked the War Department to perform the national economic mobilization function is that they trusted the military more than they did the industrialists. Although the Army did not believe this type of planning was a military function, they initiated industrial economic planning in the early 1920s.

Three significant results emerged from this effort:

1. Army planners became the most knowledgeable people on World War I mobilization.
2. Based on their findings, the Army planners presented the irrefutable fact to the Chief of Staff and department chiefs that the Army's war plan had to be based on the nation's economic potential. Only then did the Army fully accept the changes that had been brought about by modern 20th century warfare. Industrial production had become as important as tactics and strategy to military success.
3. The Army planners produced the Industrial Mobilization Plan in 1930, which was revised and updated throughout the 1930s (7:11)

Although this planning was going on, Americans were not comfortable with the military-industrial relationship. The merchants-of-death scandal, which culminated in a congressional investigation headed by Senator Nye of North Dakota, had a negative impact on American attitudes toward the arms industry (2:172). Specifically, between 1930 and 1936, the Nye Committee initiated a comprehensive investigation of American business transactions during World War I. The committee found that many of the presumably selfless businessmen who served on the War Industries Board left a record of unconscionable profiteering and questionable practices that revealed ledger book balances were more important than the fate of the nation. The committee drafted legislation with provisions for federalizing all industries and plants that could be used for making war materiel in the event the United States ever went to war again so the government would do so without borrowing. This legislation would have removed the profit abilities of industrialists. However, it also would have created a dictatorial form of government during wartime. Such ideas were summarily rejected, and the proposed legislation was withdrawn.

Thus, the Nye Committee members were left with a no win choice in any future war: they could let the industrialists mobilize the country as well as line their own pockets, or they could let the military mobilize the country, which would require the nation to give up its economic system and those very freedoms that were to be fought for. With such terrible choices, the committee members concluded that the only way to guard against the consequences of modern warfare was to *avoid* it

How Many Planes Does It Take to Fight a War?

The Air Corps planners failed to envision the scope of the coming war. As a result, in late 1938, they were still grossly underestimating the aircraft needs of the United States. Major General Henry H. Arnold, Chief of the Air Corps, described the situation as follows:

> Even after Munich [September 1938], it was difficult to get my staff to adjust their minds to a realistic plan. At this meeting, the Air Staff sat around a long table, with an easel off to one side, and I explained that events in Europe made it necessary to be ready to submit to the President, the Secretary of War, the Chief of Staff, and to Congress an air program to meet the critical conditions.
>
> How many plans did they recommend as essential? Let everyone use his imagination; nobody hold back! I went around the table asking each officer, in turn, writing his estimate on a piece of paper hanging on the easel. The estimates added up to a total of fifteen hundred, one thousand, five hundred combat airplanes to meet American requirements all over the world . . . !
>
> I was shocked. I tried the question a different way. "What is the maximum number of airplanes you could use in the Philippines if YOU were commander over there and had the defense of the Philippines in your hands?" An answer and a number was written on the easel. "And what if you were air commander in Panama?" Another figure written down. "In Hawaii? In the United States? In charge of training? Trying to protect our shores? Defending the East Coast? The West Coast? How many would you want available for a strong striking force?" Put on this more personal basis, the estimates leaped up. But in the end, they totaled only 7,500 planes.

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altogether. Consequently, committee members became arch advocates of neo-isolationism and stringent neutrality legislation. The committee's investigations were much publicized, and its recommendations had considerable impact on the public to maintain any kind of a credible military force; so much that US defense spending levels were depressed well below minimum levels (7:11-13).

Logistical functions underwent considerable change during the first 40 years of the 20th century. This change was brought about primarily by the great Industrial Revolution; the Great War, which required a total societal mobilization of the warring nations; and the management initiatives undertaken within the military.

Industrial Base

Initially, the industrial base was not perceived as part of the military consideration for waging wars. However, as controversies arose as to whether it was a private industrial sector or public governmental sector responsibility to produce armaments, both sectors began to see that their interests were interwoven. A relationship evolved in which the two sectors shared responsibilities—industry would produce the goods needed for military, and government would perform initial research and development for many items so military personnel were knowledgeable of manufacturing processes and cost considerations. Only a few arsenals and shipyards would be government owned and operated. In the Great War, the military-industrial relationship was formalized. The civilian sector mobilized the national industrial might through the WIB mechanism; the military made its requirements for goods and services known to the WIB. However, in the 1930s, the nation began to question this relationship, which ultimately resulted in an investigation by the Nye Commission. The results of the investigation and the publicity received by the Nye Commission produced a national attitude that was distrustful and a government afraid to prepare for its own defense.

Requirements

The requirements determination process was considerably enhanced during the first 40 years of the 20th century. Initially, requirements were not based on any formalized methodology. The farsightedness of a general officer or the lobbying of industrialists generated requirements. Requirements generation changed during the Great War when the size of the force and the threat drove the needs of the military. After the Great War, a formalized structure was established whereby the military specified what it needed and the private sector produced to those specifications.

Acquisition

The acquisition function saw procurement swing from a centralized to decentralized approach under General Aleshire

Access panels were laced with leather; pilots laced with bravado.

and back to a centralized system during the war. Additionally, because of the war, industrialists pressed for and received a change in contracting concepts—the *fixed-cost* type of contract gave way to the *cost-plus* type of contract. Finally, the concept of prototype competition before source selection was implemented and found to be highly advantageous to the military.

Distribution

The distribution function was significantly enhanced by the Industrial Revolution and specifically the combustion engine. The Great War forced the development of our lines of communication, and for the first time, large wartime forces were supported overseas. Horses and wagons, the primary means of transport, were replaced by motor transports, and almost total reliance for military distribution was placed on motorized ships and railroads. Even the airplane began to be considered as a possibility for a line of communication function. Finally, oceanic distribution responsibility became a Navy function when the Army transferred its ships to Navy control. A formalized distribution system for moving great quantities of men and materiel was established, and the concept of centralized command of lines of communication under the theater commander was established by General Pershing.

Maintenance

The Industrial Revolution was changing the military, particularly the conduct of maintenance operations. The internal combustion engine forced the military to produce a more technologically oriented soldier. Initially, motor transport trucks and cars were maintained by civilian mechanics, but the vast requirements of the Great War resulted in the establishment of military maintenance facilities and troops. To support such a requirement, a hierarchy of specialized depots was developed within the lines of communication.

Chapter Four

Global Logistics

1941-1955

Since so many major military events took place during the World War II-Korean timeframe, this chapter focuses on selected, illustrative major campaigns—Operations Bolero and Overlord, the North African campaign (Operation Torch), the Pacific theater, and finally, the Korean theater. A special section dedicated to an emerging new logistical dimension, airlift, is included at the end of the chapter. Because much of the US war actions were brought about by decisions made (or not made) before US entry in December 1941, opening remarks provide the historical background preceding the US declaration of war.

The Winds of War

The aggressive activities of Germany and Japan during the 1930s found *Fortress America* in a dilemma, wanting very much to halt the Nazi advances that threatened World War I Allies but not anxious to become directly involved. The Great Depression of the early 1930s had stunted American economic growth, but President Roosevelt's federal involvement with private industry had again stimulated the already broad-based US industries. Despite its industrial potential for waging war, Fortress America had done very little since the close of World War I (the war to end all wars) to improve its military might. Not only were its armies in a weakened condition, but also powerful isolationist groups had hobbled Congress and kept the United States uninvolved with issues beyond its boundaries.

Hence, although some military and civil leaders foresaw US involvement as inevitable, most attempts to prepare for the threat of European war were met with stiff civilian resistance. Even attempts to develop plans for industrial mobilization were rejected, while the existing Industrial Mobilization Plan failed to obtain congressional support to put it in effect (6:5; 3:409). In the spring of 1940, following the shock of the Dunkirk evacuation in Europe, the United States finally took measures to rearm, but these measures focused on defensive actions. A congressional inquiry had discovered that the United States not only was unable to mount an offensive campaign outside the United States but also did not even have enough equipment to defend its own territory. Problems ranged from ineffective antiaircraft guns to lack of ammunition stores. Although the United States could rapidly mobilize an army of some 1.5 million men in less than a year, equipping these men would require considerably more time. Lend-lease then became the strategy to delay for time to mobilize the industrial base.

Put simply, the Lend-Lease Act used US industries to produce goods and war materials to strengthen and support the military forces of the Allies, China, and Russia. The US purpose was initially twofold: buy time to ready our military forces and maintain friendly territory from which to base military operations directed against the Axis powers.

Additionally, lend-lease helped stimulate US industrial expansion in areas of munitions and war materiel production (6:8).

> By 1945 lend-lease goods and services of all kinds being furnished to Allies of the United States had reached an annual rate of $15 billion. Total lend-lease furnished from March 1941 to December 1945 amounted to more than $48 billion. This included aircraft and parts (to the extent of $8.2 billion), tanks and other combat vehicles and parts (3.9 billion), trucks and parts ($2.5 billion), weapons ($3 billion), ammunition ($1.5 billion), military clothing, signal equipment, chemical warfare items, and other military equipment and supplies, as well as ships, industrial equipment, raw materials, food, and other goods and services. About $31.6 billion worth went to the countries of the British Empire, $11 billion to the USSR, over $3.23 billion to France and about $1.6 billion to China (3:454).

In summary, the lend-lease decision and eventually every major strategic decision of the war were primarily based on logistical considerations, Operation Bolero was no exception.

World War II

Following the Japanese attack on Pearl Harbor, the United States was faced with deciding which enemy to defeat first.

> Here was a question of logistical limitation, and it provided the basis for the first and fundamental strategic decision for waging global war—that the main effort should be aimed first at defeating the Axis Powers in Europe while fighting a holding campaign against Japan (3:426).

Several logistical factors were key to the *Germany first* decision: limited wartime resources that indicated the need to concentrate efforts against one enemy at a time; supply line factors such as shorter distances and German U-boat threats to Atlantic lines of communication; and time needed to rebuild the Navy for Pacific operations. The War Department General Staff explained this pervasive influence of logistics in strategic planning:

Our strategy, in general, was to hold the enemy at bay while gathering our strength for offensive action and then, because we were unable, either from the standpoint of human or material logistics, to attack both at once, to give priority to the destruction of the most formidable—Germany. The holding phase of our strategy included the provision of all possible material logistics help to our Allies, the securing of lines of communications, and a preliminary offensive against the enemy's logistics potential by bombing his industrial plant, disrupting his lines of communications, and depriving him of raw material. The second phase of our strategy was implemented only when our men were trained and we were able to bring to bear preponderant weight in materiel. We then launched the all-out assault and offensive, first in Africa and Europe and later in the Pacific (6:244).

Bolero and Overlord

Although basic disagreements persisted between the United States and Britain about how to defeat Hitler's Germany, the US position was to build a massive force in the United Kingdom (UK) (Operation Bolero) and invade the European Continent in 1943 (initially coded Roundup but later redesignated as Overlord). Operation Overlord was based on the American conviction that "the quickest way to complete victory lay in a strike at the industrial heartland of Germany" (3:428). But Bolero, which had to be completed before Overlord could begin, was plagued with problems from the onset.

Never before had such a large buildup of troops and equipment been attempted, and the needs of the Army Service Forces (ASF) given the responsibility to acquire and deliver materiel to theater commanders were not accurately known. Emphasis in war preparation had been directed toward the *fighting men*, while little attention was given to the ever-increasing needs of support forces. Consequently, the Army Service Forces was undermanned and undertrained; most problems that plagued Bolero throughout World War II stemmed from these factors (4:59). For example, when Allied attention shifted to North Africa, the Army Service Forces had to suspend Bolero efforts to meet the demands of a second theater of operations.

Inadequate training of service forces resulted in confusion and costly delays. Often, it was more expedient to order new supplies from the United States than to attempt to locate items that had been stored in port facilities without documentation. Containers were sometimes shipped to beachhead areas with no knowledge of the contents inside. In general, Bolero's difficulties stemmed from factors such as inaccurate coordination with the US ports of embarkation, insufficient numbers of shipping vessels, lack of service troops, and frequent changes in Allied strategic plans (9:48).

Confusing as Bolero may have been, the operation cannot be considered a failure, and some major logistics lessons were learned from it. Perhaps most noteworthy was the practice of

(Continued on page 76)

How Many Aircraft?

One of the most important of the meetings on military policy Marshall attended as Deputy Chief of Staff occurred in the White House on the afternoon of 14 November, 1 month after he took over the post. The Western Hemisphere was vulnerable to attack, President Roosevelt asserted, and this situation demanded the immediate creation of a huge air force so that the United States would not need to have a huge army. It was politically impossible to send a large army abroad. A powerful air force was essential to back up the administration's foreign policy. The United States needed 10,000 airplanes and the capacity to produce 20,000 more per year.

Marshall believed the President's new program was unbalanced and underfunded. It favored not only the Air Corps over the Army as a whole but also concentrated too much on machinery at the expense of other Air Corps needs. The White House meeting, he recalled, was:

> . . . quite an assembly of men and a great many of the New Deal protagonists; it had to do with these appropriations we were trying to get of a military way. There was a great difference of opinion as to what it should be. The president, of course, was all for the increase in the air, but he wasn't much for getting the men to man the airships or for the munitions and things that they required. He was principally thinking at that time of getting airships for England and France.

Marshall remembered sitting "on a lounge way off to the side" in the White House meeting room. Roosevelt finished his presentation and began asking the other participants' opinions.

> Most of them agreed with him entirely, had very little to say, and were very soothing in their comments. He, of course, did the major portion of the talking. He finally came around to me . . .and I remember he called me "George," I don't think he ever did it again. That rather irritated me, because I didn't know him on that basis. Of course, the President can call you pretty much what he wants to, but nevertheless I wasn't very enthusiastic over such a misrepresentation of our intimacy. So he turned to me at the end of this general outlining . . . and said, "Don't you think so, George?" And I replied, "Mr. President, I am sorry, but I don't agree with that at all." I know that ended the conference, and the President gave me a very startled look.
>
> When I went out, they all bade me goodbye and said my tour in Washington was over. But I want to say in compliment to the President that didn't antagonize him at all. Maybe he thought I would tell him the truth so far as I personally was concerned—which I certainly tried to do in all of our later conversations. He thought I was too intent on things, of course and he was having a very hard time raising the public backing for the money, and there was a debt limitation during these early periods. But my job was to see that the country was armed, if it was possible to do so, which meant large appropriations.

Larry I. Bland
The Papers of George Catlett Marshall

The First Tasks of Logistics: Determining Requirements

At the outset of World War II and for more than a year thereafter, the greatest single problem confronting the Air Service Command was the lack of spare parts for the tactical units of the Army Air Forces. In a word, there were simply not enough spare parts to go around, and consequences were disastrous. This situation had been bad enough before the war, when as late as 1941 the Air Corps had grown accustomed to cannibalizing almost 20 percent of its new aircraft to provide needed parts for the rest of the fleet. But in the months following Pearl Harbor, supply shortages had worsened to the point that 40 to 45 percent of the combat aircraft in the United States were grounded for lack of parts, and it was not at all uncommon to remove engines from US-based aircraft for shipment overseas.

Essentially, there were two reasons for the alarming shortages. In the first place, the construction of complete aircraft was more profitable than the production of spare parts, and in the prewar years, government agencies had found it difficult to obtain the concurrent delivery of aircraft, spare engines, spare propellers, and spare maintenance parts. Once we entered the war, however, the Joint Aircraft Committee in Washington acted swiftly to correct this fault, stipulating that no aircraft could be delivered from the manufacturer without its full complement of spares and that all shortages were to be made up within 10 months after March 1942. Although the government agencies did not attain their goal—more than $500 million worth of spare parts still had to be delivered to Allied nations in the first 18 months after Pearl Harbor—their demands brought about a decided improvement in production.

As important as this achievement was, it was not enough to solve the problem of supply shortages; all the supplies in the world would not help the Army Air Forces until the Air Service Command could obtain the right types and numbers of items and have them shipped to the tactical units. This meant that the logistics command had to learn to determine as precisely as possible what and how much was needed by the forces in the field. As the subdepot manager at Long Beach, California, soon found out and later noted, without such knowledge it was almost impossible to carry on a sustained and effective support operation. "There was no way," he observed:

> . . . of telling what to anticipate, no way of knowing what supplies to stock . . . . They have no idea from one day to the next what is coming in. They carried an awful workload . . . . The whole problem at Long Beach was a supply problem.

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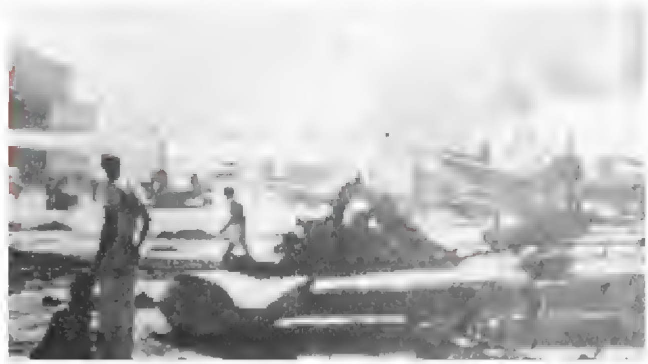


The Japanese invaders severely damaged aircraft and ships but neglected the bulk of the logistical facilities that allowed reconstitution of American airpower.

A Shortage of Service Troops

In general, planning for logistics immediately preceding World War II, in both the United States Army and Navy, was grossly inadequate. The only reason it was not grossly inadequate in the US Air Force was that a separate air force did not exist at that time.

As we started to mobilize for World War II, only 11 percent of the Army consisted of service troops, compared to 34 percent at the end of World War I. Instead, we needed more support forces than ever before, basically because mechanization of combat equipment of our Armed Forces had leaped forward between the two world wars.

The unrealistically low ratio of service troops to combat troops made itself felt almost at once. In the spring of 1942, few trained service troops were available for overseas duty; and service troops, beyond all others, were required in the early phases of the war. It was imperative that they prepare depots, receive equipment and supplies, and establish the essential services for the combat troops.

Major General Jonas L. Blank
"The Impact of Logistics Upon Strategy," *Air University Review,* March-April 1973

Hickam Field, 7 December 1941.

Building a Harbor at Normandy

Landing craft were just not capable of handling the kind of volume necessary to support a massive advancing force. They were never intended to do this. The key, recognized from the very start, was to have a harbor capable of handling hundreds of liberty ships *where there was no harbor to begin with.*

At the urging of Lord Mountbatten and finally with the prestige and power of Churchill overcoming doubters, an artificial harbor the size of Dover was built in Mother England and towed across the Channel to France.

A big order? Dover itself was an artificial harbor—but it took *7 years* to build! We had less than 6 *months* to design and fabricate the harbor and 2 w*eeks* to put it together after towing the pieces across the Channel to Normandy.

Great caissons, constructed in Britain, were known as *phoenixes*. They were huge cement barges 200 feet long, 60-75 feet tall, weighing 6,000 tons each; 149 of them were towed and sunk off the beaches at Normandy. Docks on steel pontoons, called *beetles,* went out one-fourth of a mile to pierheads. Put together, the piers and pierheads were called *Mulberries* and were built at US and British beaches for offloading both landing craft and Liberty ship freighters.

All told, we tugged 113 cement and rubber bladder breakwaters, 149 phoenixes, 23 pierheads, 6 pontoon roadways, and 74 old ships that were scuttled as breakwaters. It took 200 tugs moving continually across the Channel.

And this grand scale Rube Goldberg harbor did the job far in excess of expectations.

Lieutenant Colonel David C. Rutenberg
Lecture, Air Command and Staff College, 1985

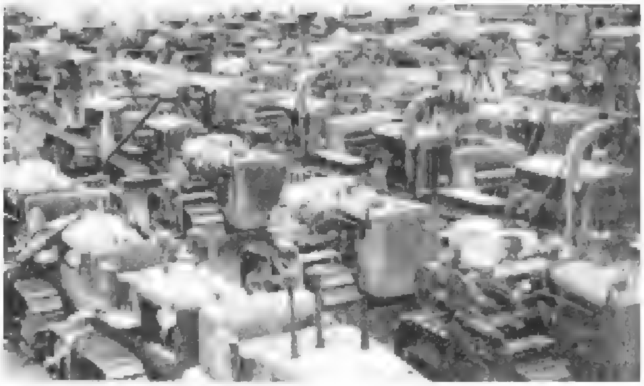
A concrete caisson, used for a *Mulberry* breakwater, is shown after being towed from England. The caissons were built to withstand summer Channel weather. They ranged from 175-200 feet in length, 25-60 feet in height, and weighed up to 6,000 tons each. Assembled in lines, the caissons formed the *phoenixes* capable of serving as moorings for 28-foot draft Liberty ships.

Causeways from the piers to the French beaches were able to rise and fall with the tides.

What's not well known about Operation Overlord is that the direct military objective of Overlord was neither strategic nor tactical, but logistical. The primary objective of the plan read: "To secure a lodgement on the continent from which further offensive operations can be developed." Since it was clear the war would be a battle of industries, we had to be able to rapidly deliver our industrial output to the front lines. The primary need, then, was for port facilities. The Normandy location was selected because of physical characteristics and its location between two major port groups—Cherbourg and South Brittany. Until ports could be taken, refitted, and opened, the beach had to handle the influx of troops and supplies.

Lieutenant Colonel David C. Rutenberg

Logistical Confusion



Hundreds of Caterpillar tractors await loading for the invasion of France.

Six days after D-day, the English ports were so badly scrambled that troops could not be sorted into the landing craft to which they were assigned. The situation became so disorganized that even available ships could not be loaded. Only extraordinary measures such as indiscriminate shipment of troops without regard to craft-loading plans, plus an absence of enemy interference, allowed us to straighten out the chaos.

Many vessels arrived in France with contents completely unknown to shore personnel. One consequence was a frantic search for 81-millimeter mortar shells, needed in the hedgerow fighting, because shore troops did not know which ships carried what cargo. They called forward a large additional quantity of these shells from England. Even when the special shipments were made, a ship-by-ship search was required to find the desperately needed munitions.

Huge quantities of supplies were unloaded from ships and piled up in such disarray that they could not be identified and issued to combat forces. Ports became so cluttered that identifiable supplies in the holds of other ships could not be moved ashore.

Eyewitness accounts verify the confusion, which in a sense is understandable in the midst of a massive invasion. The point is that most of it was unnecessary. It was not that we did not know better but that we did not apply what we knew. And it could have spelled the difference between victory and defeat if the defenders had had the wisdom and ability to concentrate their defenses quickly. Fortunately, the Germans believed, as we hoped they would, the main thrust would come later directly across the English Channel, so they did not commit their reserves to stop the Normandy landings until it was too late.

Major General Jonas L. Blank
"The Impact of Logistics Upon Strategy," *Air University Review*, March-April 1973

Thousands of jerry cans are filled from railroad tank cars at a decanting area in Belgium, December 1941.

Logistical Confusion

In North Africa, the Germans frittered away their early gains after coming within an eyelash of making the Mediterranean a German lake. Again, brilliant tactical execution was undone by inadequate logistics support. Only about 10 percent of Rommel's fuel requirement for his tanks was delivered during the critical days when the fate of North Africa hung in the balance. What he needed could have been delivered. This was proved the next year when German equipment and supplies poured into Tunisia in response to the American landings in Africa, but by then it was too late. Field Marshal Kesselring, the German commander in chief in Italy, and Rommel disagreed on many aspects of the North African campaign. They did agree, however, after it was over, that it was primarily a logistics battle and that their promising opportunity for decisive victory evaporated because transportation had been badly planned and clear organizational channels for logistics support had never been established.

Major General Jonas L. Blank
"The Impact of Logistics Upon Strategy," *Air University Review*, March-April 1973

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preshipment of military materiel in advance of troops. Until this time, it was customary to move troop units and their equipment about the same time. Since US invasion forces were to complete training and arrive in the United Kingdom at one time, it was determined that the pressure of discharging men and supplies in the United States would create unmanageable congestion. Within 6 months after this decision, "54 percent of cargo unloaded in the US was equipment for troops scheduled for later arrival" (4:69).

As mentioned earlier, a part of Bolero's problems stemmed from a change in strategy when the United States committed itself to the North African campaign.

North Africa

US involvement in North Africa (Operation Torch) was prompted by a number of factors, most of which were logistically oriented. The logistics buildup in England was going to require a long time before the invasion of Europe could take place. Politically, Roosevelt felt he needed a victory soon, and German forces in North Africa were not as strong as in Europe. Additionally, Germany had important interests in North Africa's middle eastern region because of its fuel reserves, which they, like the British, needed desperately. Further, getting supplies to the Pacific theater made control of the Suez important, as were the lines of communication through Persia used for moving supplies to Russia.

The Allies were faced with delivering forces simultaneously from the United States and United Kingdom. The forces would go directly from boat to combat in three geographically separate locations. The invasion date allowed only 3 months to prepare and involved great distances. To make matters worse, no fewer than 57 changes were made in strategic plans during a short 17-day period (3:518). This, of course, caused much initial confusion in logistics planning. All these efforts were considered first of a kind for US armies. Operation Torch was hampered by coordination problems as well. Once the forces were readied for sea transport, the Navy said they could not safely escort a convoy of its size. Consequently, many vehicles were left behind, greatly limiting the mobility of US forces once in Africa.

Other problems revealed the fact that ASF plans were not in tune with tactical planning. Ships arrived for loading with code numbers instead of names, and equipment had to be marked with wartime code numbers prior to shipment. Also, the fact that logistics was, for the first time, required to load vessels to be discharged in the order in which they would be needed revealed that combat loading had not received much thought beforehand. In all, the "invasion of North Africa in November 1942 was a graduate lesson in logistics when too many officers had not yet completed even elementary school in that subject, but on the whole, the officers learned their lessons well" (3:518).

The invasion of North Africa served as a proving ground for developing data for supply replenishment, service troops

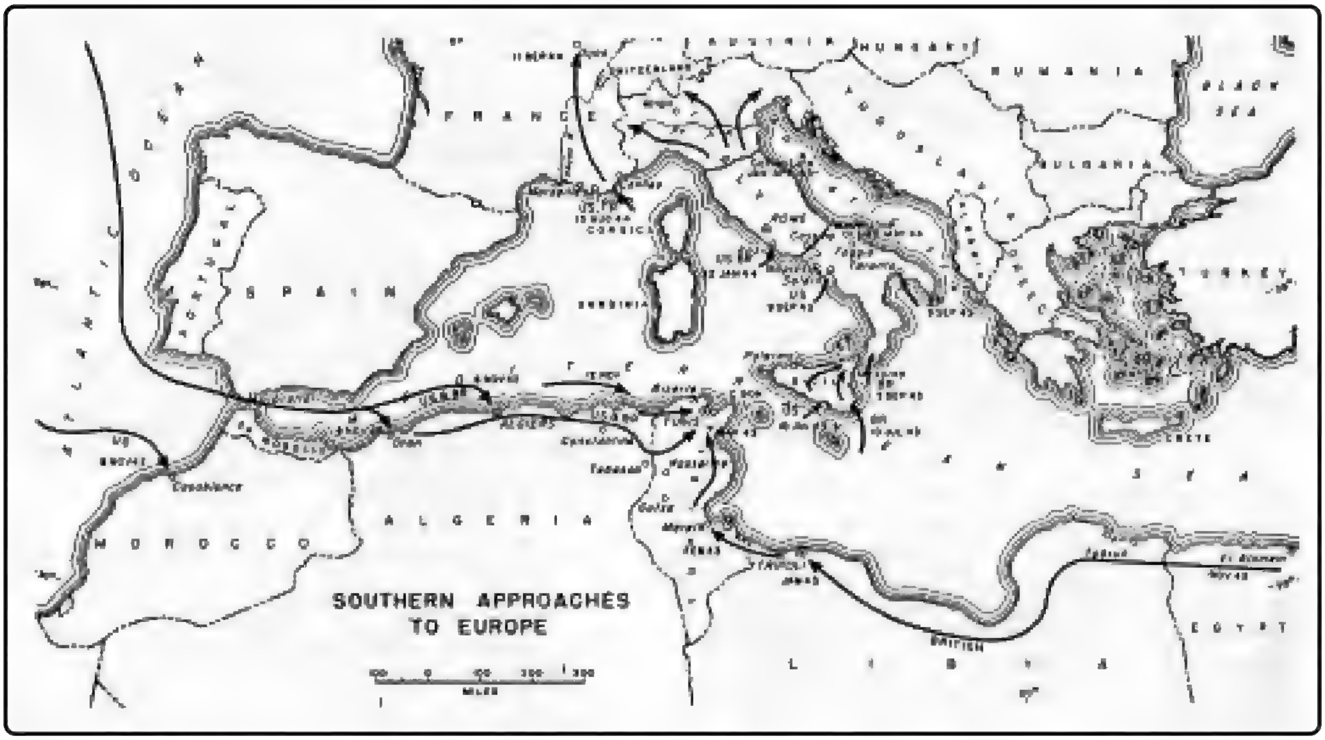
Water at Alamein: 1942

Rommel's water supply always was a headache to him at Alamein. More than 1,000 of his men had deserted because they were dying of thirst. He surmounted that first dire emergency by loading some schooners with water at Tobruk and beaching them behind his line at Alamein. Then he developed some wells at Fuka, where underground water was plentiful. From Fuka, he used our pipeline to pump the water eastward as far as Sidi-Abdel-Rahman, just behind this battleline.

That use of my pipeline irked me. In one way, however, it eventually turned out to our advantage. To pump water through that pipeline, the German sappers had to repair the damage done in demolition by our engineers during the retreat. In the great surge forward after the final Alamein battle, I was to find that the Germans had done their repair job well but that the speed of their own retreat had precluded their doing much demolition themselves. Consequently, I found that section of the pipeline, which the enemy had used, almost in even better repair than we had left it.

Major Peter W. Rainer
Corps of Royal Engineers, *Pipeline to Battle*

US supplied locomotives could provide alternative transportation from Casablanca to Tunis even if Allied Mediterranean forces were cut off from supplies delivered over the beaches.



The *friction of war* comes in many guises to hamper the flow of ground operations.

Colonel John Elting, in *American Army Life*, aptly entitled this 1941 photograph *End of the Army Horse.* Soon after this photo was taken of the 1st Cavalry Division, the mounted regiments were disbanded. Colonel Elting pointed out, though, that Army cavalry units would again enter vogue in the Italian mountains and Burma.

If one were to be asked what an internal combustion engine disliked most, high on the list would come sand, salt, heat, and humidity.

Air Chief Marshal Sir David Lee, RAF

and troop replacement, casualty estimates, and amphibious assault planning and support (3:519). These many new lessons proved useful throughout World War II but especially during the Normandy invasion of Europe.

Normandy

Normandy was, of course, was neither the first nor the only invasion of Europe during World War II, but it does represent the largest, most significant movement of US forces in Europe. In *The Sinews of War*, we read:

> Logistics was a constant and overriding factor in the conception, planning, and execution of the Normandy invasion in June 1944. It will be recalled that the question of logistics was greatly responsible for the preference of American military chiefs for a cross-channel attack for the main effort as opposed to a Mediterranean or other approach on the Continent. In development of the plans for the great invasion, logistics dominated the definition of objectives, the choice of landing sites, the size of the assault force, and plans for building up the initial forces and pushing inland. Availability of shipping—including landing craft, coasters, troop transports, cargo ships, tankers, and lighters—and capacity of discharge on the Continent were the most common items for planning and worrying sessions in the crowded weeks of preparations preceding D-day (3:523).

The game plan for invading Europe contained considerably more coordination between strategic and logistics planners than had been previously done. Service planners were extremely effective at beaching operations and managed to put 130,000 men and their equipment ashore during the initial assault. Two artificial harbors, called *Mulberries*, were towed across the Channel and positioned to receive cargo for shuttle to the beaches. Although ships were rapidly offloaded and returned for resupply, great problems again "arose in keeping track of what cargoes were being carried by what vessels and in trying to hold to a system of unloading according to priority" (3:525). In general, the beachhead logistics plans worked much smoother than in North Africa. This was largely because of more and better landing craft.

Many problems, however, resulted from the inability to adjust to rapid army movements. The subsequent race across France by Allied armies revealed new logistics weaknesses. What had started as a battle of unloading at the beaches had now turned into a transportation battle to keep pace with the armies racing toward Germany. This so-called race constituted a major change in strategy and precipitated the formation of the *Red Ball Express* line.

The *Red Ball Express* was an improvised system of any and all trucks that could be spared (mostly 2-1/2-ton cargo carriers) to drive supplies across existing roads to the spearhead of the army attack. Although historically viewed as a remarkable achievement in delivering supplies, consideration must be given to other aspects. The initial strategy for invading Europe had been to quickly capture the port of Cherbourg, which was located near Normandy, and then continue north toward the port of Antwerp. These ports were considered highly important to ensure that large volumes of follow-on troops and equipment could be rapidly distributed. When the US commanders digressed from the original plan, these ports were secured much later than scheduled, allowing time for the Germans to effectively ruin the port of Cherbourg prior to the US conquest. This, combined with the fact that French railways were damaged far worse than expected, caused many difficulties while moving supplies to the troops in combat.

One interesting note is that the trucks used in the Red Ball Express would not have been available had not a truck buildup been occurring in England in preparation for the reopening of the Burma Road in the Pacific theater. In less than 3 months, the makeshift Red Ball supply lines were played out, mainly due to vehicle breakdowns and ever-increasing distances from the beaches to the front lines. Most vehicle breakdowns could be traced to untrained drivers who did not adhere to preventive maintenance practices (3:528).

Ironically, but embarrassing to logisticians, a clear principle of all offensive operations is to engineer a breakthrough in enemy lines. Yet the breakthrough in Europe seemed to be the one contingency that the service forces were unprepared to support! This logistics limitation subsequently led to a major strategic decision by General Eisenhower to develop a *broad front* offensive, which was much slower than the single thrust. This strategy was implemented to allow the logistics forces to catch up, which they eventually did. Despite the speculation

(Continued on page 95)

English and US railroad equipment being unloaded at Cherbourg. It took a combination of motor, rail, and air transport to supply advancing forces. Even so, lack of transportation frequently tightened the reins on Allied operations.

Fortress Europa

Despite their propaganda, in which *Fortress Europa* was so frequently painted as being utterly inviolable, it was clear to (the Germans) that Allied troops could be put ashore—might even be put ashore in large numbers. But no one knew better than they that vast quantities of supplies had constantly to be put ashore as well—supplies of food and fuel and ammunition, of motor trucks and tanks, of repair parts and medical supplies and replacements, of everything upon which an army lives and without which, in the face of organized opposition, it becomes little more than a useless mass of humanity incapable of either attack or defense. They knew that no army, save a large and well-equipped one, could make significant headway against them on the Continent and that the larger such an army was and the more extensive its equipment the greater would be the problem of keeping it supplied.

It was here that the Germans felt themselves to be reasonably safe, for they knew that even were such an army able to land it would fail miserably if its supplies failed. They realized that the men—and even some of their light equipment—could no doubt come ashore across the beaches. But the special landing craft intended for use on unprotected beaches had not even been designed at the time the Germans reached this conclusion. It was largely on that account that they were satisfied the thousands upon thousands of tons of supplies and equipment that would daily have to follow, if the invading army were to maintain and widen its hold, could only be landed at and distributed from the more important seaports—ports that the Germans were determined to defend to the last and to destroy thoroughly before permitting their surrender.

It was with this in mind that every continental port on the Bay of Biscay, the English Channel, and the North Sea, from the Spanish border to the Skagerrack and especially of northern France and Belgium, was heavily manned and sturdily fortified and that orders were given to their defenders by the German dictator himself that they were to fight to the last man. In other words, when the invasion came, the German armies would absolutely prevent the landing of supplies in quantity. With that accomplished, such armies as might come ashore, regardless of their numbers, could not possibly do other than fail.

Hawthorne Daniel
For Want of a Nail

Teamster Tribute: World War II

The original plan to capture the ports of all of Brittany was discarded, for the determination of the Germans to fight a major battle west of the Seine, coupled with the advantageous position the Allied army had attained, caused a shift in Allied plans. The German forces that had withdrawn behind the defenses of the Brittany ports were, therefore, left largely to their own devices, while the Battle of Normandy was fought and won.

Fuel trucks travel the legendary *Red Ball Express* route across France.

"This meant," said General Eisenhower,

> . . . that we had to rely for our maintenance at a most vital period of the campaign upon the original supply lines through Cherbourg, the Arromanches Mulberry, and the Normandy beaches. Some cargoes were unloaded through the minor harbors and over the beaches of northern Brittany, but they represented only a small fraction of our total needs. The bulk of the supplies for the Third Army had to be transported by the long, roundabout route down through the Cotentin and then eastward around the German pocket resisting at Falaise and Argentan. The Third Army, when it got into its stride in the dash across France, was advancing at a speed of up to 40 miles a day, and our transport services were taxed to the limit. The incentive offered by the chance of a smashing victory, however, drove the men in whose hands the maintenance of supply rested to feats of superhuman accomplishment. The spectacular nature of the advance was due in as great a measure to the men who drove the supply trucks as to those who drove the tanks.

Hawthrone Daniel
For Want of a Nail

For the most part, Army schools and the War Department General Staff in peacetime planned, trained for, and studied combat operations. To a great extent, the Army neglected the logistics problems of operation. This was a deficiency that proved to be costly.

Final Report, Army Service Forces, July 1947

FOCUS

Supporting the Breakout

Merely a Logistical Operation

The second major objective of Overlord, after establishing a lodgment, was to secure the South Brittany peninsula and establish a port of entry in the Quiberon Bay area for supply of US forces in the breakout across France.

This was Operation Chastity. But, basically because the Eighth Corps commander, General Middleton (otherwise one of our finest commanders in both Europe and the Far East), apparently did not comprehend the strategic significance of his logistics-oriented assignment—he preferred to move eastward with Patton and *never carried out Operation Chastity!*

Failure to carry out the *Chastity* resupply plan slowed the Third Army's advance and may have lengthened the war considerably.

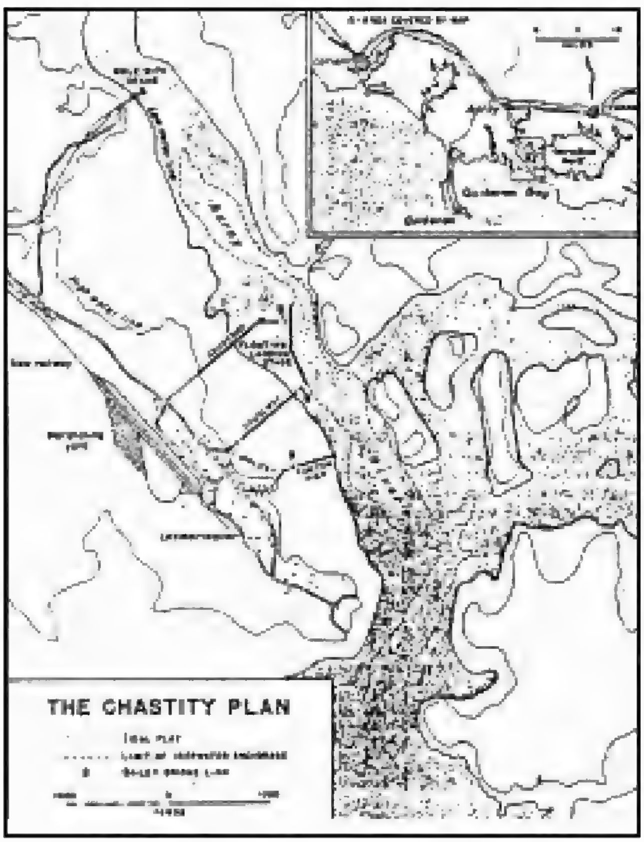
From that point on, Patton's Third Army was forced to draw supplies from the beaches and northern ports later opened. Quiberon Bay's ports were graced with an ideal rail linkage direct to Paris. But this didn't matter, because the port was not made available. Not only were the beaches and northern ports unable to adequately supply Patton, but he also had to draw supply and fuel from other ports, in effect *taking support* from the US and British forces moving northward closer to the coast.

It does not take too overactive an imagination to forecast the possible result of paying closer attention to executing this logistical operation.

If only chastity had been carried out, there would likely have been no stifling lack of supplies and fuel for Patton; there would have then been more for *other* Allied forces; there would have been no stalled Allied drive in the fall of 1944; there could then have been no reconstitution of the German force for the Battle of the Bulge; there may well have been a victory in 1944, long before the Russians were even close to Czechoslovakia or Berlin; there would have been no split Berlin, no East Germany and—who knows?—No SS-20s today.

We will never know, of course, and you can play *what if* all day. But the example makes it pretty clear that *logistics can have a tremendous influence on the course of war.* And with mass and concentration of power being such a key element in the European struggle, it becomes clear why General Eisenhower came to regard logistics as such a key determinant of victory.

Lieutenant Colonel David C. Rutenberg
Lecture, Air Command and Staff College, 1985



Failure to carry out the *Chastity* resupply plan slowed the Third Army's advance and may have lengthened the war considerably.

Chastity: On-Scene Testimony

Grand strategy didn't win the war. It was combat tactics that did it. Because of logistical failures, the grand strategy was completely botched after the first stages of the invasion.

General Patton was notorious for his lack of logistical knowledge, but major blame cannot be attached to him for the failure to carry out Chastity [plan to seize South Brittany ports for more supply support]. He was under Bradley's orders. Middleton's corps, after being detached from the Third Army, operated as directed by Bradley. It was Bradley's responsibility that the corps did not carry out the Chastity plan.

General Patton was a great combat general. He saved the Allies in the Battle of the Bulge by a magnificent display of military tactics. His great faults were his contempt for controlling orders from higher echelons and his refusal to pay sufficient attention to his logistical needs.

To sum up, *ComZ* could have done a much better job had it had a different organization. Lee, its commanding general, was not the man for the command. The whole supply setup from Supreme Headquarters down was badly organized. It could not have adequately supplied the combat forces without the facilities of the South Brittany ports and railroads.

Bradley failed to carry out his assigned mission to secure the South Brittany ports for several reasons. First, he overestimated the ability of the German forces in Brittany to be a real threat to our flanks and against our greatly superior forces. Second, he never really trusted Patton and his tactics. Third, he underestimated the logistical need for obtaining the use of Quiberon Bay and the railroads running east from there. These were most costly mistakes.

Harold L. Mack
The Critical Error of World War II

The Industrial Base: Where the *Master Switches* Are

Nitrogen and hydrogen are paramount in war. Nitrogen is a basic ingredient of most explosives; hydrogen is an essential element in the fixing of nitrogen for explosive purposes and in the manufacture of synthetic gasoline. This relationship holds during peace- and wartime. Only the emphasis changes. During peacetime, munitions are limited to commercial explosives for mining and construction purposes and a minimum amount for military explosives required in target practice. During wartime, war munitions and fuel for internal combustion engines come first. Without nitrogen and hydrogen, belligerents would perforce revert to hand-to-hand infighting, as was the practice throughout history right up to the invention of gunpowder. A continuously ensured supply of these elements is the prime essential in war.

Germany has no natural sources of nitrogen, and at the beginning of this century, her local production was confined to inadequate quantities derived from by-product ammonia recovered from coke ovens and gasworks. It was realized in Berlin that the importation of all nitrogenous products would be automatically cut off by the blockade at the outbreak of hostilities. In these circumstances, up to 1913, Germany could threaten, but she could not strike.

So Hohenzollern had to put off zero hour for World War I until adequate synthetic nitrogen capacity had been put into operation and the country had become independent of Chilean nitrates. The invention by a Jewish chemist named Haber of the process for the fixation of nitrogen from the atmosphere opened up new vistas, and I .G. Farben, that old offender, who had always been so closely involved in Germany's war plans, rushed, at the behest of the German warlords, the study of the commercial application of the Harber process and the completion of the first nitrogen plant at Leuna. By 1914, production was in full swing, and this relieved the German General Staff for the first time of the fear of a possible shortage of nitrogen for their armaments. Reassured on this point, they had no further hesitation in bringing to fruition their plans for plunging the world into war.

The two largest plants in Germany were built prior to 1914; they have continued in operation and are still today undoubtedly the foundation of Germany's munitions supply. One, the Leuna plant, with an annual productive capacity of 750,000 tons of nitrogen is the world's largest and is just south of Merseburg on the Saale River. The other, the Oppau plant, is a few miles east of Mannheim. Most of the other German chemical nitrogen plans are in the Rhine Valley. Germany had also harnessed all the nitrogen plants in occupied territory to her war machine; one of the largest of these was the Norsk Hydro plant at Rjukan, Norway. Other important ones were located at Sluiskil, Holland; Toulouse, France; and Ougree-les-Liege, Belgium. The destruction of any of these plants, many of which have been bombed, is a serious blow to German war economy.

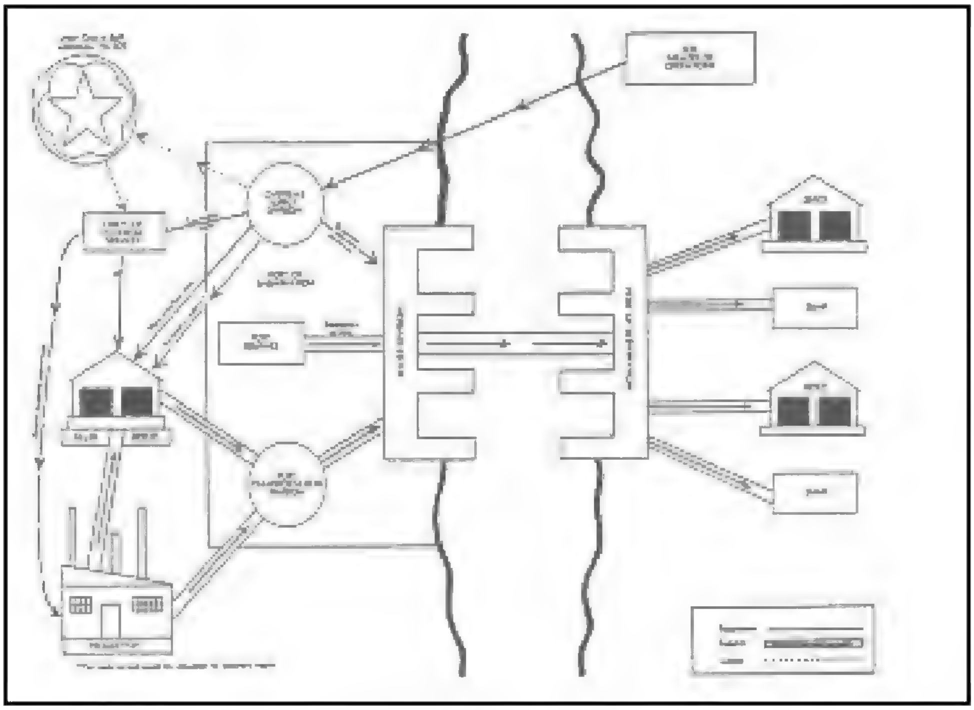
The world productive capacity of chemical nitrogen has been determined by both peacetime requirements and by the prospects of war. War requirements are appreciably in excess of peacetime demand. So we find that, in the decade before this war, consumption was running at 40 percent of capacity; but as war drew nearer, consumption rose very sharply to 60 percent for the aggressors were building up reserves. With the return of peace, it may again fall to the normal 40 percent. It can be said in very truth that consumption of nitrogen is a barometer of war and peace.

Murray Harris
The Logic of War, 1944

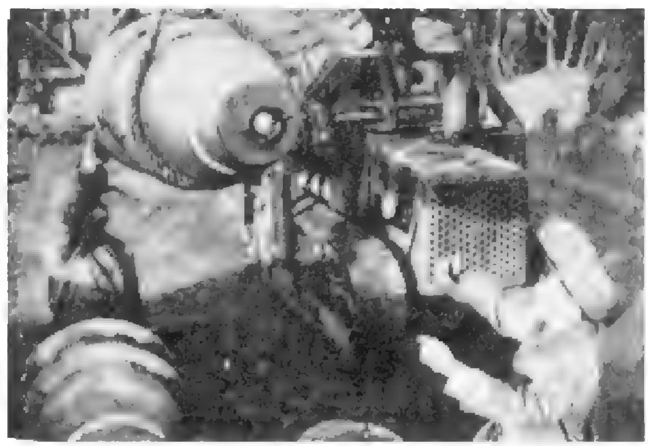
Lines of Communication—the Logistical Lifeline

England was well covered with support and training sites in preparation for the invasion of Europe.

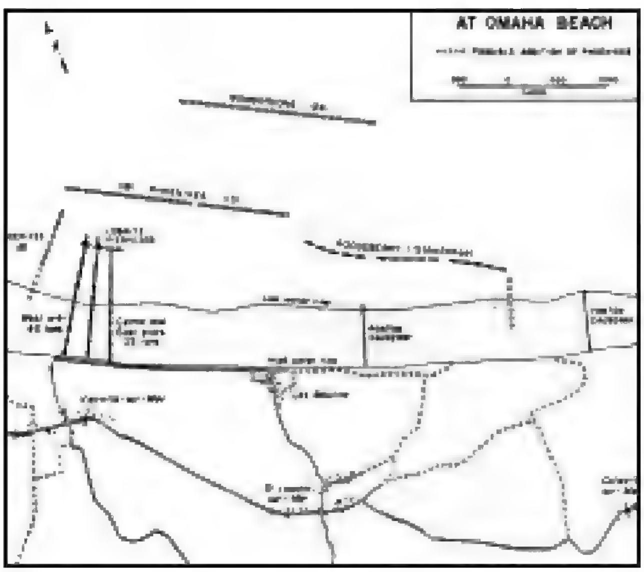
Many four-engine C-54s, used for long overwater hops, were flown on contract by commercial carriers. This TWA-operated Skymater is running up its engines at an Air Transport Command base in Greenland.



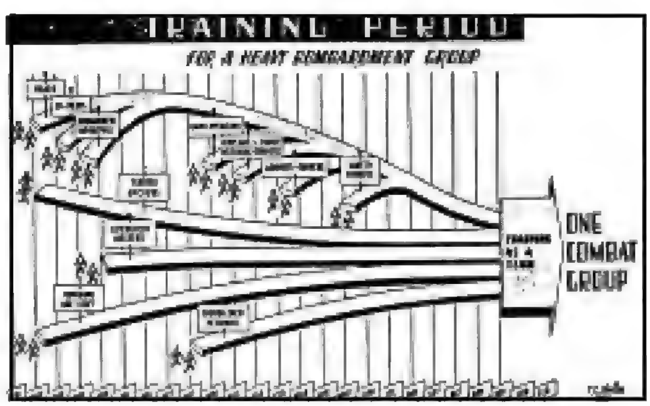
The port of embarkation in the overseas supply system, 1942.



1,000-pound bombs being stacked for open storage in England. Vast quantities were stored across England, protected only by camouflage nets.

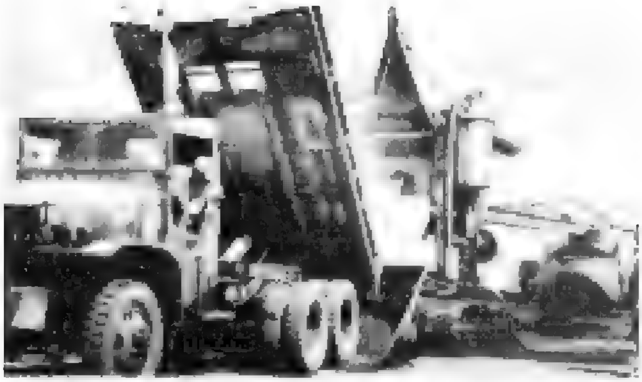


Building a harbor where no one would ever build a harbor.



Sand in the Logistical Gears

Down for Parts: The Early Awakening of the 9th Bomber Squadron



An engineer company at work on an airfield in England. Gene Gurney, in *A Pictorial History of the United States Army, recounts that as of 1 June 1944 "129 airfields were available in the United Kingdom for the Eighth and Ninth Air Forces. In addition, there were 3 airbase depots, 7 combat crew and replacement centers, 2 reconnaissance and 1 photographic reconnaissance fields, 19 troop carrier fields, 11 advance landing grounds, and 2 miscellaneous fields. In addition, living quarters for more than 400,000 air force personnel were furnished, plus thousands of square feet for storage."*

Once the United States entered the war, the inextricable ties between logistical support and combat capability became all too apparent. Nothing could more clearly illustrate how crucial logistics was or how unprepared we were than the experience of the 9th Bomber Squadron. In January 1942, the 12 B-17 *Flying Fortresses* of this unit were flown more than halfway around the world to Java in the amazingly short time of little more than a week. No sooner had these planes arrived at their destination than they were sent into combat, and at first, they enjoyed great success. But this soon proved to be ephemeral, for the 9th Squadron, and similar units paid a heavy price for the speed with which they had entered the war. They had arrived in the Far East with hardly any supplies, no spare parts, and no mobile repair facilities—in short, without the ground support to keep the planes in the air. Soon enough, attrition took its toll, and in a matter of weeks, the 9th Squadron and other units were ground down and forced to evacuate what they could to Australia. Painful though this experience was, it nevertheless taught America's military leaders a lasting lesson, which was best expressed in the words of the Army Chief of Staff, General George C. Marshall:

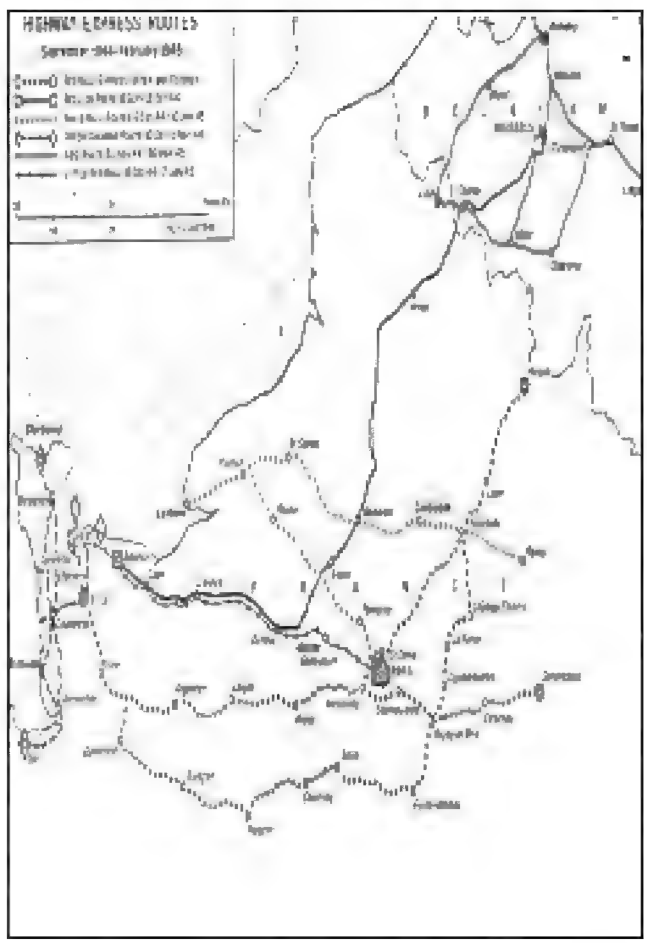
> While this sudden reversal of a movement halfway around the earth demonstrated the mobility of the airplane, it also demonstrated the lack of mobility of air forces until a lengthy process of building up ground service forces and supplies (mechanics, ordnance and radio technicians, signal personnel, radar warning detachments, antiaircraft, medical and quartermaster units, as well as the troops to capture airfields and defend them against land attack, and the accumulation of repair machinery, gasoline, bombs and ammunition) had been laboriously completed by transport plane, passenger and cargo ship—the last two largely being the slow-moving means of transportation.

Logistics: An Illustrated History of AFLC and Its Antecedents, 1921-1981

Patton and Gasoline

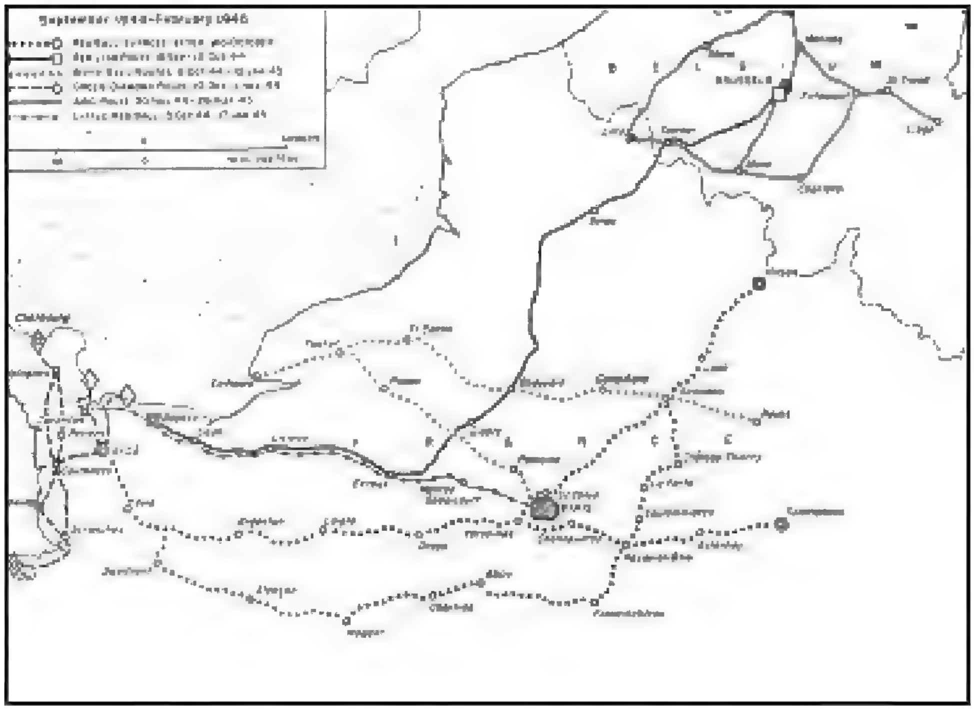
To solve the gasoline shortage, Patton initiated one of the most ingenious operations of the war—the Red Ball Express. This was a fleet of trucks that formed a convoy hundreds of miles long. Carrying only gasoline, they drove around the clock the 1,000-mile round trip from the front lines to the gas dumps. One war correspondent who observed this operation wrote:

> I well remember passing these supply trains on the Verdun-Paris highway in September 1944 and being struck with the almost nightmarish quality of the task they were trying to perform. In the cab of each truck sat the driver, usually a Negro, with a mate beside him. They drove like maniacs, hitting the bumps at full speed, rounding curves on the wrong side of the road, roaring through towns; and always the air was filled with the screeching of their brakes and gears . . . these truck drivers usually ate on the road and slept in their cabs. They were an epic fraternity . . . .



It was a typical Patton operation—fast, reckless, but efficient.

When on occasion his ingenuity failed, he ordered his division commanders to fight "until lack of supplies forces you to stop," and when this happened, he told his men to dig in. In a directive to General Eddy when he was running out of ammunition, one again sees his overwhelming desire to move forward:



> Eddy called me to state that his allowance of shells for the eighteenth was nine thousand, but I told him to go ahead and shoot twenty thousand, because I could see no reason for hoarding ammunition. You either use it or you don't. I would lose more men by shooting nine thousand rounds a day for 3 days than I would by shooting twenty thousand in 1 day—*and probably not get as far.*

Again, his usual concern for the number of casualties and his fervent desire to advance against the enemy.

The supply item that finally slowed Patton to a standstill in Europe was gasoline for his armored vehicles. For a period, it stopped entirely. He noted, "At first I thought it was a backhanded way of slowing up the Third Army. I later found this was not the case, but the delay was due to a change of plan by the High Command, implemented, in my opinion, by General Montgomery." Patton said of this turn of events:

> It was my opinion then that this was the momentous error of the war. So far as the Third Army was concerned, we not only failed to get back gas due us, but got practically no more, because, in consonance with the decision to move north, in which two corps of the First Army also participated, all supplies—both gasoline and ammunition—had to be thrown in that direction.

Patton's drive continued; however, he told his commanders "to continue until the tanks stop and then get out and walk."

Patton then called upon another aspect of American ingenuity for help. He promised 3-day passes to the men who could steal the most gasoline drums—full or empty, American or enemy. The US divisions of First and Ninth Armies not assigned to Third Army were on occasion stolen blind. Any shortages that existed in Patton's army were supplemented in every possible way; and it was not unethical to get supplies from other American outfits, even though they were *borrowed* without permission. The recipients asked no questions.

Edgar F. Puryear, Jr
Nineteen Stars

Problems of Tactical Resupply

For reliable, large-scale supply operations, it was necessary to have airfields for landing as near as possible to where the supplies were needed. The lack of these fields was a principal factor in limiting the whole effort. When a forward field could be developed quickly for supply operations, as the one at Orleans for supporting the Third Army, air combat units soon moved in and preempted it for the use of bombers and fighters. The other principal hindrance to maximum air delivery was the competing demand of the First Allied Airborne Army. In the summer of 1944, the ground armies were moving more swiftly than the airborne army could plan; a whole series of operations had to be canceled as the ground forces raced past the planned objectives before the airborne operation could be mounted. But the preparation for these operations meant that supplies had to be built up for their support and transport planes of the Troop Carrier Command had to be diverted to be ready to carry both men and supplies.

James A. Huston
The Sinews of War

Battle of the Bulge Logistics

One reason the counteroffensive failed was that German combat service support, transportation in particular, did not keep up with the advance of combat formations. While it is true that the German munitions production had waned since 1939, the Fuehrer's troops ran out of ammunition not because there weren't enough shells at the Rhine dumps but because the ammunition didn't make it to the front. Loss of trucks due to battle damage and mechanical failure had been heavy throughout 1944, so heavy that new production could replace only half the losses. Some units were equipped almost solely with confiscated vehicles, which had to be abandoned upon mechanical failure for lack of repair parts.

These transportation problems alone were enough to preclude successful supply support for tactical operations of the Wachtam Rhein. To make matters worse, Germany still made extensive use of horses for transport. Traveling over treacherous, shelled, snow-covered roads during a season when forage was not readily available, many sickened and died.

Unlike the supply vehicles of Germany, those of the US Army were seldom impeded by roadblocks and traffic jams. Furthermore, US logistical and tactical moves were not subject to harassment or attack from the air. Many American divisions had sufficient vehicles to carry their supplies; others were available through line-of-communications sources. The much criticized size of the US logistics *tail* paid off during the Ardennes *campaign*, for in contrast to Germany, there were always enough transport resources to satisfy demands for troop and supply movement.

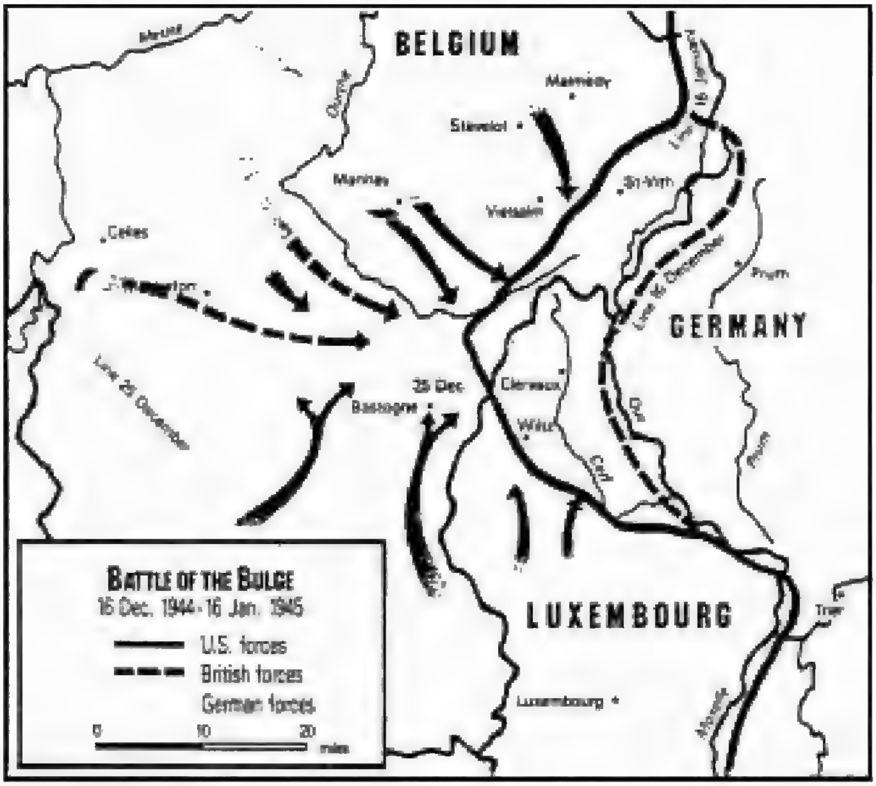
Fuel supply presented particular problems for the German Army. Like all other supplies, fuel did not move quickly as the armored advance. Nor had German planners anticipated that bad terrain and inclement weather would reduce by one-half the mileage-per-tank consumption figure they had projected. Furthermore, the German attackers did not capture nearly as much enemy fuel as they had hoped. During the first week of the counteroffensive, the petroleum shortages experienced by the German Army were caused mainly by transportation problems, bad roads, traffic congestion, and vehicle failure. After 23 December, when the weather cleared, fuel supply was impeded by Allied bombings of roads and German supply points.

In contrast, US Army units never experienced serious fuel shortages, even though they had to move, destroy, and occasionally abandon fuel supplies. Despite their possession of a map of American petroleum, oil, and lubricants (POL) installations, the Germans captured no more than several hundred thousand gallons of petroleum.

Problems in maintenance, which in combat is dependent on transportation for the recovery of vehicles, also plagued the German Army. There was a shortage of tank retrievers, and after 23 December, the few that were available became the target of Allied fighter-bombers. Consequently, the high German tank losses can be attributed as much to mechanical failure as to battle damage. Only six tank repair companies deployed to the front, and the spare parts situation became so critical that new German tanks were cannibalized at a depot west of Koblenz.

Americans had few major maintenance problems. Initially, a few ordnance companies were overrun, but most tank maintenance personnel and equipment were moved safely out of enemy range and continued to function effectively. Many medium tanks were lost from battle damage, especially during the first 2 weeks of the offensive, but these losses were filled by diverting tanks that had been allocated for British use.

"Logistics of the Battle of the Bulge," *Army Logistician* (January-February 1985)



Gentlemen, the officer who doesn't know his communications and supply, as well as his tactics, is totally useless.

General George S. Patton

The Pacific Theater in World War II: Challenges to Air Logistics

Captain Richard W. Quick

To an extent never before contemplated in military enterprise, the global nature of World War II demanded forces that could cover vast distances rapidly and apply firepower to constantly shifting lines of battle and target priorities. These needs made the expansion of airpower's role in warfare inevitable, because then, as now, airpower's unique value lay in its ability to combine three key characteristics—speed, range, and flexibility.

Yet these qualities were brought to fruition with far less ease than we often recognize. The air arm's *speed* and *range* led to its employment in unprepared and inhospitable areas, demanding severe adaptation from a fledgling air logistics corps. And each inch of mission *flexibility* attributed to airpower had to be forcefully wrenched from a quickly conceived, often dry, support pipeline. The phrase *we'll wing it* could well have been coined to describe the logistical support of US airpower in the China-Burma-India (Far Eastern) and Pacific theaters. The crushing burden of logistics occupied the time of many commanders and eventually led to major changes in operational strategy and tactics.

Pipeline to the Far East

The Far East was still a European, mostly British, colony at the start of the war. Unlike the European theater, in which a commercial and military logistics infrastructure already existed, the eastern colonies had developed along a predominately agrarian model. A system of highways and railroads had not been developed, so most transport was by barge or coastal freighter. By 1939, the Japanese held all the major ports and waterlines of communication. Before their advance had been halted in the fall of 1943, they had pushed all the way to the border of India. The major ports of Saigon, Singapore, Bangkok, and Rangoon—as well as the major rivers: Nakhon Chai Si, Salween, and most of the Irrawaddy—were in Japanese hands. Most important were Bangkok and Rangoon, both located at the termini of major rail and waterlines of communication.

The famous Burma Road fell in the spring of 1942. From then on, US support of Allies in China depended solely on air supply. The first flight over the *Hump* from the Assam valley to western China was on 8 April 1942 (3:60).

Before details of the *Hump* mission and operations of the XX Bomber Command in China are discussed, the global position of the theater of battle should be examined. A quick glimpse at a globe reveals an operational theater more than 10,000 miles from the United States. The primary means of supply from the United States to India was by ship, from either the east or west coast. Shipping time from Los Angeles to Bombay averaged more than 2 weeks; from Newport News to Bombay exceeded a month (1:75). From Bombay to the jump-off point for the *Hump* was nearly 1,500 air miles—considerably more via narrow gauge railroad or barge.

Support of the air operations was virtually impossible with such extended supply lines, so for high-priority items, such as R-3350 engines for the B-29, Air Transport Command (ATC) flew a ferry service direct from the States. Pilots would change at every stop, but the plane would continue on to the final destination. By 1944, using the air route, planes could deliver parts from stateside to Calcutta in under 70 hours, an air distance of some 11,000 miles (1:78).

The primary purpose of the *Hump* airlift was to demonstrate enough military capability to keep China in the war as a possible base for attack on the home islands of Japan. (3:58) At this time, Japan already occupied much of China, and the Chinese accordingly had seen fit to put their civil war on hold until the Japanese were evicted. Every item needed by the American forces in China had to be airlifted over the *Hump*. This mission grew from a humble beginning in 1942 when it airlifted about 300 tons a month to its peak of more than 70,000 tons in July 1945.

While 70,000 tons seems small today, it was a significant achievement from a 1945 perspective. Three primary cargo aircraft were then in use—the C-47, C-46, and C-54. Their payloads ranged from 2.5 to 4 to 6 tons, respectively, on these missions (3:62; 128). The C-54 was a late entry and was the only four-engine craft. This was an important feature when flying the route over the *Hump*, which stretched for 550 miles over jungle and 20,000-foot mountains. Loss of an engine on a two-engine aircraft spelled doom for the ship and usually the crew. It was a route well marked by the aluminum graves of those aircraft and crews that did not make it.

Supporting the Bombing Campaign

While the *Hump* airlift may be the most famous of the Far Eastern air operations, it was not the most militarily critical, being solely for support of a Chinese holding operation that awaited conclusion of the European campaign. Strategic bombing, well taught in Europe, was about to be applied against the Japanese from the bomb bays of the B-29 Superfortress.

The Twentieth Air Force was formed for this purpose and, after much political maneuvering, was permitted to report directly to the Air Corps Commander, General Arnold, who was a member of the Joint Chiefs of Staff. General Arnold convinced his colleagues that the unique mission and characteristics of the B-29 required the unit to report to him rather than to a theater commander as would normally be the case (1:35). The range of the Superforts allowed them to roam over the Pacific theaters commanded by Generals Stilwell and MacArthur and Admiral Nimitz. To preclude continual changes in mission and priorities, operational command was retained in Washington.

However, logistics and administrative support was provided by the *theater* commander, an arrangement that proved more satisfactory than might be expected but ultimately depended on a good deal of *self-help*.

Hand-Built Airstrips

The XX Bomber Command was tasked to attack Japan from China under the operational code name *Matterhorn*. In mid-1943, the Chengtu area was selected as the base for B-29 operations. Chengtu's greater security resulted in its being chosen over the more strategically located Kweilin preferred by General Chennault (1:65). This proved to be a correct decision, as Kweilin fell to the Japanese in late 1944, only shortly after the XX Bomber Command began operations out of Chengtu.

Flat, with good weather, Chengtu was well suited for bomber operations. Unfortunately, it lacked the finer luxury of *airfields*. Constructing four heavy bomber bases would be a difficult task even in the States, but in China, the job was enormously problematical. For one thing, there was no heavy equipment available. Instead, more than 300,000 Chinese were drafted as laborers from villages within a 150-mile radius of the area (1:68) By May 1944, four 8,500-foot bomber strips had been completed. Each strip was about 19 inches thick and was equipped with 52 handstands, all *hand-built*. Stones were carried from local streambeds; crushed with hammers; combined with sand, clay and water; carried in baskets on shoulder yokes or in wheelbarrows; and then rolled in place by hand-drawn rollers. The payroll for this construction was so large that Chinese currency had to be imported, using valuable cargo space on none other than the already overburdened *Hump* airlifters (1:70;71).

Operation Matterhorn

With airfields finally complete, operations could begin. Recall, though, that everything needed by US forces in China had to be flown in via the *Hump* pipeline; supplies for the XX Bomber Command—avgas, oil, bombs, parts, and food—were no exception. The basic premise of Matterhorn, due somewhat to the shortage of organic airlift but mainly to the AAF concept of the bomber unit as a self-contained unit, was that it would be self-supporting. This meant B-29s would be used as transports. Some B-29s were stripped of virtually all armament and used as aerial tank cars (1:87). Without question, aviation gasoline was the real *long pole* in the Matterhorn tent. It took seven round trips of 11 hours each to ferry in enough avgas *for one mission* against Japan (2:325).

As if these obstacles were not enough, the Chinese workers presented another—accidents. The local Chinese held a superstition that they were closely pursued by demons. If one could shake his demon, his life would improve immensely. A big B-29 was just the thing to shear a clinging demon from a laborer's back. The workers would hide along the runways waiting for departing or landing Superfortresses. When one was sighted, they would run in front of the propellers hoping their demons would be struck. Obviously, sometimes it was the Chinese that were hit by the props. While the other Chinese watching would laugh hysterically at such great fun, reporting these occurrences to headquarters demanded a great deal of paperwork (2:334). To ease the administrative burden, such accidents eventually ceased to be reported.

Building the Chengtu airfields.

Operating from the Marianas—Isley Field, Saipan.

Evolving Maintenance Concepts

Despite the problems, the first Matterhorn mission put up 98 bombers, a feat the Eighth Air Force had taken 14 missions to accomplish in Europe (1:93). Further efforts to increase the support of B-29 forces initiated wide-ranging changes in maintenance concepts and organizations, which continued to evolve throughout the war. These new concepts were very significant to the development of today's Air Force and warrant further discussion.

In the *traditional* air organization employed in the European theater, maintenance responsibility was divided into four echelons. AAF 65-1 defined these levels:

> *First echelon maintenance* will normally consist of servicing airplanes and airplane equipment; preflight and daily inspections; and minor repairs, adjustments, and replacements. All essential tools and equipment must be transportable by air.

Second echelon maintenance will normally consist of servicing airplanes and airplane equipment, performance of the periodic preventive inspections; and such adjustments, repairs, and replacements as may be done by the use of hand tools and mobile equipment authorized by Tables of Basic Allowances for issue to the combat unit. This includes engine change when the organization concerned is at the location where the change is required. Most of the tools and equipment for 2[d] echelon can be transported by air; but certain items—such as transportation, radio, and so forth—necessitate ground means of transportation.

Third echelon maintenance embraces repairs and replacements requiring mobile machinery and other equipment of such weight and bulk that ground means of transport is necessary. Units charged with this echelon of maintenance require specialized mechanics. This echelon includes field repairs and salvage, removal and replacement of major unit assemblies, fabrication of minor parts, and minor repairs to aircraft structures and equipment. Normally, this echelon embraces repairs that can be completed within a limited time period, this period to be determined by the prevailing situation.

Fourth echelon maintenance includes all operations needed to completely restore worn or damaged aircraft to a condition of tactical serviceability and the periodic major overhaul of engines, unit assemblies, accessories, and auxiliary equipment; the fabrication of such parts as may be required in an emergency or as directed in technical instructions; the accomplishment of technical compliance changes as directed; replacement, repair, and service checking of auxiliary equipment; and the recovery, reclamation, or repair and return to service of aircraft incapable of flight.

Echelons one and two were performed by the using organizations, echelon three by Air Service Command's (ASC) theater-based subdepots and echelon four by ASC's main depots. Note that the organizational level maintenance resources were owned by the *squadrons*, but the subdepots, which performed mostly what we today refer to as *field* or intermediate level work, reported to the Air Service Command, not the local combat commander.

In the European theater, this factor resulted in two common problems. First, depending on squadron taskings, one squadron may have been working its maintenance personnel around the clock while its sister squadron counterparts within the same bomb group were playing basketball. Second, there were frequent complaints that the ASC's subdepots were unresponsive to mission requirements, and the bomber commander had no control over the problem (4:17).

In June 1944, General Arnold directed the XX Bomber Command to control third echelon maintenance and the supporting service groups (1:121). The maintenance personnel from the service groups and bombardment squadrons were grouped, and some economies of scale were realized. This organizational structure would carry over when the newly constituted XXI Bomber Command moved into the Marianas. In essence, it remains the mainstay of strategic bomber maintenance doctrine today.

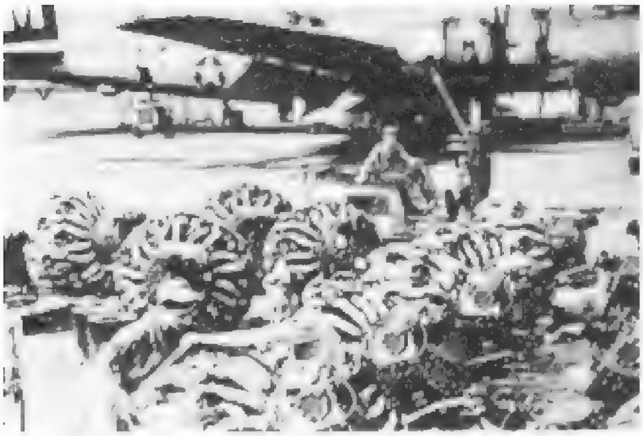
Move to the Marianas

It was soon realized that missions from China were relatively ineffective considering the massive logistical inputs necessary. At the same time, island bases were being prepared in the South Pacific for attacks against the home islands of Japan. The preparation of air bases in the Marianas, some 5,000 miles from the United States, was fraught with its own logistical problems. Not least among these was the fact that there was no single manager for either construction or operations. The Navy was responsible for shipping, construction, and airdrome maintenance; the Army for supplies, clothing, general equipment; and the Army Air Forces for air technical supplies (1:537).

Regardless, the XXI Bomber Command began operations against Japan with fewer support problems than in China. Maintenance support improved with the new organizational arrangement. All supply and maintenance activities were centralized under Colonel Clarence S. Irvine, Deputy Chief of Staff for Supply and Maintenance, from November 1944 to the end of the war (1:544). A supply controller and a maintenance controller were in charge of all activities in their areas. Service center personnel were grouped with maintenance personnel in functionally aligned shops, with the responsibility of supporting all assigned aircraft. In the shops, production line methods were used, and the work force could respond to the different requirements in the groups with maximum effectiveness (1:544). Although there was considerable resistance from various units, General LeMay gave strong support and squelched opposition. In 1945, General Spaatz confirmed that these changes had contributed to the "unparalleled operational accomplishments of the Twentieth Air Force" (1:545).

With the supply of operable aircraft ensured, the Twentieth Air Force was able to mount steady attacks against Japan. The intensity of these attacks and a change in tactics resulted in still another logistical problem. The original plan had been to use high-explosive bombs as had been used in Europe. Because of a variety of factors—one being the highly flammable buildings in Japan—tactics were changed to replace high explosives with incendiaries. A concurrent change to tactics was made primarily for logistical reasons—the marginally effective high-altitude attacks were brought down to low level where greater precision could be achieved. The driving force for this adjustment was the B-29's unfortunate reputation as an engine eater. It would swallow a valve and catch fire with great regularity. In an effort to ease the strain on the engines and thereby their logistics support, LeMay reasoned:

> With those overheating engines, it began to seem that this high-altitude stuff was strictly for the birds. The airplane has been breaking down. There are something like 55,000 different parts in a B-29; and frequently it seemed that maybe 50,000 of them were all going wrong at once. I feel



B-29 Maintenance at Guam: R-3350 Engines.

Night work during the fire blitz.

> that the majority of our losses were due more to our own mechanical problems than they were to the Japanese defense system.
>
> Main thing to do, it seemed, was to get them down in altitude. Then we'd get a lot more hours' service out of each engine. And, since the bombing had been stinko most of the time, [we could] teach the crews to put patterns on the target. (2:343)

The gamble paid off almost immediately. The first pattern flown low was against a Burmese cement plant. The crews were able to increase their bombloads significantly as a result of requiring less fuel for climb-out. "When the smog cleared," LeMay recalled, "There was absolutely nothing left of that cement plant. Our people had done a perfect job."

LeMay added refinements to the low-altitude incendiary tactic such as removing bomb-bay fuel tanks and even all defensive armament, substituting nighttime, single-ship, and combat box patterns for large high-altitude formation attacks and intensified radar and precision-bombing training. The results were described dramatically in the official history, *The Army Air Forces in World War II* (Vol V):

> The physical destruction and loss of life at Tokyo exceeded that at Rome (where 10 out of 14 wards of a much smaller city were consumed) or that of any of the great conflagrations of the western world—London, 1666 (436 acres, 13,200 buildings); Moscow, 1812 (38,000 buildings); Chicago, 1871 (2,124 acres, 17,450 buildings); San Francisco, 1906 (4 square miles, 21,188 buildings). Only Japan itself, with the earthquake and fire of 1923 at Tokyo and Yokohama, had suffered so terrible a disaster. No other air attack of the war, either in Japan or Europe, was so destructive of life and property. (1:617)

The lower altitudes also allowed for larger bombloads, which, in turn, caused another logistics problem. A shortage of firebombs rapidly took place. Naturally, the pipeline to the Pacific, 3 months long, was filled with high-explosive bombs (1:540;541). It took several months for supply to catch up with the change in tactics.

Roots of Current Doctrine

Many concepts formulated in the World War II Pacific theater influenced the way the Air Force operates today. Probably the most obvious is the centralized maintenance organization. General LeMay would further refine this concept after the war. In fact, it is still in use today in commands that find central control of resources effective. Also, the seed was planted for developing unified commands so that theater, rather than service, priorities would drive the operation of the support pipeline.

In the Pacific, as in other theaters, close examination reveals the extent to which logistical muscle and technique had to be developed before airpower could capitalize on its *potential* unique advantages of speed, range, and flexibility.

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The history of failure in war can be summed up in two words: TOO LATE, too late in comprehending the deadly purpose of a potential enemy, too late in realizing the mortal danger, too late in uniting all possible forces for resistance, too late in standing with one's own friends.

General Douglas MacArthur

General Kenney on Far East Supply Concepts

When we went into the Philippines, it was at a time when Europe seemed to be needing more shipping than it had ever needed before and that minor war over there was surely absorbing a lot of everything. So they cut down the number of boats that we had, and we were really in tough straits. When we first went into New Guinea, we had this bright idea that you couldn't do anything unless you had a 120-day stockage of everything. We cut that down to 90, with some misgiving on the part of MacArthur's supply crowd, and then I cut it to 60 and even to 30, and even the Air Force began to howl about 30 until they saw that Air Transport could pick up the slack.

When we started into the Philippines, the shortage of shipping was so acute that we landed on the island of Leyte with 5 days' stockage, and we never got more than 5-day stockage. We didn't want more than that because, by this time, we had air supply. We were flying gasoline, we were flying bombs, we were flying food, we were flying stuff for the infantry as well as ourselves. We were really doing a job with air transport. Where in the original part of the game we had to build warehouses and set up a depot and build terrific warehouses to stock stuff in and the stuff would get spoiled and that bad weather and everything, now we didn't have any stockage in there at all to amount to anything. These depots were largely depots repairing wrecks, and if we needed a spare part, we would fly the thing in. We would fly engines in. We were overhauling engines in Australia, and as the thing got off the test stand, it went right into an airplane. And inside of 5 or 6 hours, they were putting it in a bomber up in New Guinea.

Suppose, on the other hand, you do it the old-fashioned way. You take the silly engine off here and disassemble half of it and wrap it up in little packages, and they get lost when they open the crate. Everything is supposed to be proof against this damp tropical weather and proof against the salt spray that they get, because they always put out stuff on the decks.

These big heavy crates are made so you can drop them from the crane to the bottom of the hold, in case they did put them in the hold, and not break anything. Everything is filled up full of cosmoline, and then they load these boats until they have enough for a convoy. A month goes by. This thing has gotten all rusted, and the pistons won't move, and the crankshaft has red spots on it. When you do get the cosmoline off it, you haven't an engine until 2 months have gone by.

There was no doubt, as soon as we started in doing this stuff, that was the way to run a fast-moving war, especially when you were on a shoestring. And we finally found out that the way to run a war was on a shoestring anyhow, that was modern war, faster, and the whole Pacific campaign that MacArthur had would still be going on trying to get out of Port Moresby if it hadn't been for the transport.

General George C. Kenney
Speech for Air Force Association, 1952

A Logistics Concept for Combined Air Operations: China-Burma-India/1945

Everything was not set for the final big push to drive the Japanese from Burma. The 12th Bomb Group (M) remained at Fenny; the 459th Fighter Squadron was moved southward from Chittagong to Rumkhapalong; the 4th Combat Cargo Group was moved from China to Hathazari and Doharzari; fighter squadrons of the 1st Air Commando Group and the 2d Air Commando Group were moved into the fields of Hay and Cox's Bazar respectively. All of this airpower was being amassed in the Arakan area of Southeast India.

To ensure coordination of supply and maintenance efforts of Air Service Command troops, Colonel Douglas Johnston, Commanding Officer of the 54th Air Service Group, was appointed Field Representative to the Commanding General, India-Burma Air Service Command. This appointment, in effect, made the 54th Air Service Group the keystone of supply and maintenance activities in support of all combat units operating in East Bengal and the Arakan areas during the period 29 January–2 April 1945. The combined efforts of all three Air Service Groups in East Bengal and the Arakan made possible maximum combat and air-supply operations of the air-arm of the AAF units listed. The fighter aircraft gave close support to the ground forces, strafing enemy positions or bombing them with high-explosive or napalm incendiary bombs; the medium bombers gave both tactical and strategic support to the ground forces, destroying enemy positions and interrupting lines of communications. The planes of the combat cargo groups delivered by air practically all of the supplies and munitions of war needed by the Allied ground forces, following the forward echelons as they pushed southward and eastward in the Arakan and those driving southward from Shwebo to Mandalay to Rangoon. The success of this combined operation is already recorded in the history of military operations in India-Burma.

John P. Bondurant
The 54th Air Service Group, 1943-1945

The Pacific—Learning the Meaning of *Infrastructure*

When we brought airplanes into the sweating jungle of the Pacific, we stepped back thousands of years.

We brought the latest aircraft, the most modern mechanical flying wonders from the most mechanical-minded country in the world, equipped them with trained, expert technicians both on the ground and in the air, and then dumped everything into a primitive green sea of trees where a canoe's outrigger was a device of marvelous ingenuity.

To the jungle archipelago, the swampy, unmarked, unroaded, unbroken land of cannibals, headhunters, and savages who regarded poisoned arrows as the latest tricky implements of war, we brought P-38s, P-47s, B-25s, and B-24s.

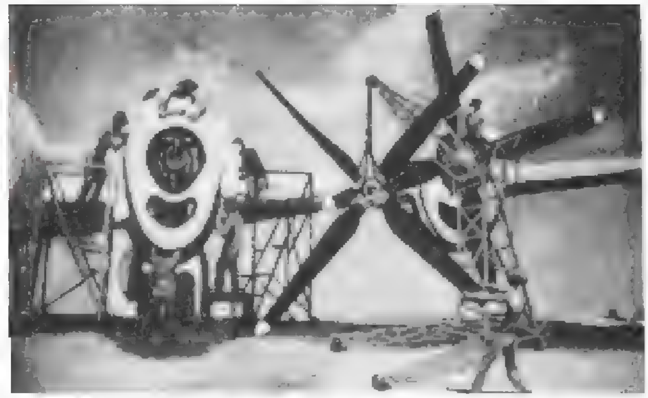
Next to a witch doctor's hut, still stinking from the greasy brews concocted with screeching incantations to native gods, still decorated with the shriveled heads and the rib bones of slain enemies, we set up repair shops and communication depots, antiaircraft batteries, and radar installations.

This, from the beginning, was the difference between the war against Japan in the Southwest Pacific and any war we were fighting or ever had fought anywhere else—the country itself, its whole unbearable strangeness and unfamiliarity, its sense of entire removal from anything we had ever known. The country itself had to be met, figured out, and overcome. Only after that could we turn our attention to a tough, savage enemy who already was there, who already was entrenched and protected within it.

Somehow airplanes belong over Europe, because Europe is modern. It knows of airplanes and trucks and radio and radar and tanks. Europe is a continent of cities. It is fitting to use airplanes to fight over Europe. There is a sameness in time.

Fighting with airplanes in the Southwest Pacific was an anachronism greater than that of the Yankee who invaded King Arthur's court with a firearm. It would have been closer in time and understanding and relative civilizations if suddenly we had found ourselves fighting over medieval Europe or in the French and Indian wars or with Cortez and the Aztecs. The Pacific was ancient beyond understanding to us.

Air Service Command mechanics in the South Pacific overhaul the twin Wright radical engines.



The 2,200 horsepower engines of the B-29 had to be maintained in the hot sun, the aircraft being too big for available hangars. (*Fortune* art, October 1945)

Even in the primitive sections of North Africa where we first went to fight in enemy-held land, there were some points of identification. There were people who were distant from us but who were close and understandable compared with the cannibal in New Guinea.

There were cities in North Africa. There were roads, docks, piers, bridges, stone buildings, and stores.

In the Southwest Pacific, there was nothing. There were but a few collections of grass buildings here and there from Australia to the Philippines. There was nothing we could call a town. Only one or two places could we dignify with the name village.

There was not a single dock, wharf, or pier capable of large-scale unloading of war materiel. We could not use the scrubby little ports the enemy used because he unloaded from barges that never had to cross an ocean and could beach anywhere or into shore. He could do this because his supplies were lighter and scantier than ours. He lost a large proportion of them, but he could afford that too.

Where, occasionally, he had a decent harbor—in Rabaul, for instance—he also had too many men there to make it worth our while to put him out. We bypassed and contented ourselves with lesser places. We had to work harder with those places, but we saved our men and left great numbers of his men behind us to wither on the vine.

We could not use the paths the enemy cut in the jungle because he carried his meager supplies on his back, by native carrier, or by mule pack and never needed a road that would accommodate heavy trucks and tanks in wet weather.

We could not use the primitive bridges he built because they were intended to support men or light wagons and not heavy vehicles. There was nothing there for us when we arrived but the jungle.

The impact of the jungle was in many ways greater than the impact of the enemy. We fought trees and swamps, mountains, disease, strange flying things, insects, and crazy noises more than we ever fought the Japs.

It bred a strange feeling in our men. There was no escape in surroundings. There was no Algiers to visit, no Cairo, not even the dirty, twisted streets of a Constantine.

After awhile, fighting in Italy or France, men came to cities. They found places where people spoke to them, where people were glad to see them, made a fuss over them, cheered, and gave them a glass of wine. They were made to feel good. They could laugh. Pictures were taken of them, and some of the ennui, exhaustion, filth, and deadlines of war could be wiped away for a little while.

There was nothing of this in the Pacific. From the time that our fighting men left Australia until the time they arrived in the Philippines, more than 2 years later, they lived in a jungle nightmare—a poisonous, lush, terrible summation of all the unknowns, all the terrors. There were no cities, only grass shacks; and when some of the men finally got to the Philippines, they looked at a two-story stucco house with unbelieving eyes. There were no welcoming natives, nobody who ever felt he had been liberated, no girls to cling to jeeps, no cheers, no waving flags.

Just painful, exhausting creeping through the jungle, where this year's fighting seemed the same as last year's and where the distances were so great the end never seemed in sight.

There was nothing of a life outside the life the men brought with them. Inside their camps was a semblance of America—2 feet from the last tent in the line was the jungle.

There was nothing to absorb the shock of war. The men had to absorb the shock among themselves, as though floating in space alone, for months and months, until the months became years. The men were pushed together in a way that few of our soldiers anywhere else were pushed together. Each little bit of America that was clawed out of the jungle was clawed out personally, by machine and by hand and with effort and desperate need. Need, because without the reminders, you might think this was life, that Kansas City, Idaho, Texas, New York, Maine, Georgia, and California were just delirious dreams caused by malaria and jungle heat and dengue.

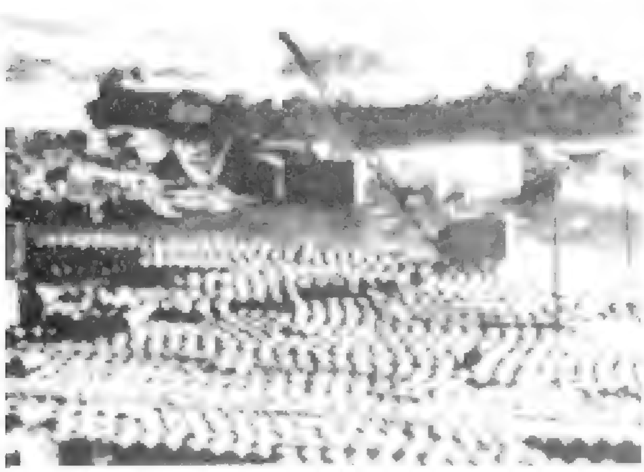
The jungle closed in again the moment you turned your back, the way water closes in around stones on shore when the tide rises. And that was more than just a mental hazard. You would begin to think strange things—an airplane might fall into the jungle right under your eyes, a huge Fortress, for instance, and in a day, the jungle would swallow it up silently. In 2 days, the green thickness would enclose it so that you might fly a hundred feet above it, looking for it and not seeing it.

The enemy counted on the jungle when he started out on world conquest. He figured the jungle and the weather would beat us as they had beaten other men into lethargy and insanity for hundreds of years. He figured that what little was left of us when nature got finished he could handle easily. Besides, we were supposed to be flabby. Remember the jitterbugs and the loafers who used to stand on street corners?

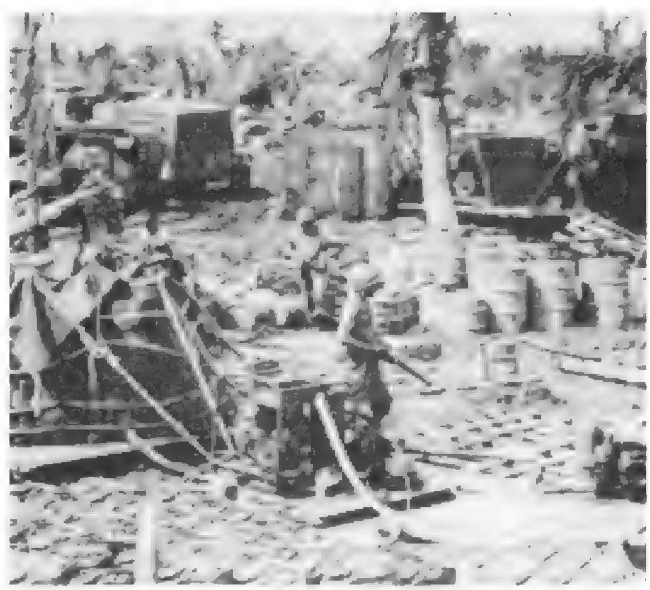
That concept was the enemy's gigantic error of the war. Because this concept was in error, the war did not go the way they planned it. So sure was he, his men were never trained in retreat. So sure was he, he had no backlog of technicians and mechanics to replace those specialists we left stranded behind in our leapfrogging to the Philippines.

Our failure to fight his war, the war he planned, was one of the chief reasons he lost the war and lost it long before the end of the final battle.

Major James Sunderman, Editor
World War II in the Air



Barrels of precious aviation gasoline (avgas) crowd the beach at Hungnam during evacuation. General MacArthur saw no practical advantage in holding a beachhead on the eastern coast of North Korea, so he planned this relocation of US X Corps to South Korea to reinforce the Eighth Army. The avgas supplies allowed air cover for protection of withdrawing forces.



Valuable water supplies at Leyte, 1944. In addition to steel drums and jerry cans, collapsible bladders were used for bulk movement and storage.

Development of the *DUCK*

To appreciate the story of the DUKW, an acronym to be explained later, one has to go back to the Allied landings on the North African shore during November 1942. As every student of military history knows, an opposed amphibious landing long has been regarded as one of the most hazardous and chancy of operations. When US troops pushed ashore in Morocco and Algeria, they employed 629 small craft, mostly flat-bottomed sea sleds of rather flimsy construction.

Although the enemy did not put up any really sustained resistance, the operation was a near disaster; 34 percent of the landing craft were lost or disabled during the action. Inept handling by inexperienced crews and defective design that let sea spray drown the engines allowed many of the boats to broach and wallow helplessly in the surf. Many capsized and essential supplies and some lives were lost. Those boats that reached the beach often were stranded there, run hard aground, and, therefore, were unable to make repeated trips back to the supply ships standing offshore in deep water. For lack of vehicles to clear away the accumulating boxes of equipment unloaded in disorderly haste at the shoreline, virtually every square yard of accessible beach soon was piled high with confused masses of materiel. The native population looted happily among the unguarded crates.

Clearly, small personnel-landing boats and towed liferafts were not well suited to the task of unloading tens of thousands of tons of essential cargo, gasoline, ammunition, and food that would be needed immediately, long before the regular ports were cleared of the enemy and put back into operation. Fortunately, before the Allied forces had to attempt another assault over the beaches, a technical solution, the DUKW, came to hand.

The Initial Concept

The story behind the development of the DUKW is a curious one. In the fall of 1941, the Corps of Engineers invited the National Defense Research Committee (NDRC) to explore the possibilities of developing an amphibious jeep, a modified version of the standard quarter-ton 4x4 vehicle, with a hull added. The committee, one of President Roosevelt's happier creations, dated back to June 1940, when the fall of France jarred the nation into a more aggressive approach to defense preparedness. The purpose of the committee was to tap university and industrial resources to supplement research and development already being undertaken by the Armed Forces to devise, as its charter indicated, *instrumentalities of warfare.* Although the committee had Army and Navy representatives, its members largely were civilian. This fact almost certainly gave its deliberations and decisions a different complexion from those encountered within the military departments also working on the *instrumentalities of warfare.*

As NDRC pushed ahead with the amphibious jeep project, it gradually became clear that the Army had no idea of just how the resulting amphibian was to be used. This lack of doctrine complicated the task of design substantially. As it turned out, the amphibious jeep proved to be of but limited value tactically. It had some utility as a reconnaissance vehicle, but its negligible carrying capacity made it of little value as a cargo carrier.

Gestation

The effort expended in developing the amphibious jeep was not lost, however. NDRC staffers realized if a larger amphibious truck could be devised to ease the task of shuttling cargo over the beaches from deep-draft cargo vessels standing off shore the process of unloading could be greatly facilitated. This new truck would not only simplify the task of getting vital munitions ashore fast to assist an initial assault but also cut down turnaround time for seagoing cargo vessels. Any such reduction in turnaround time held the promise of significant reductions in the total requirement for new ship construction. With these thoughts in mind, NDRC officials seized the initiative and took their proposal to General Motors, where the company's engineers turned out an experimental model in a scant 38 days.

The newly developed amphibious truck was a standard 6x6 Army truck (the designation 6x6 indicating that all wheels were powered) sheathed in a welded steel hull and equipped with a propeller controlled by the steering wheel. The tires could be inflated or deflated at will by the driver. This innovation would provide low pressure for a large traction surface when crossing loose beach sand or high pressure when the vehicle was traveling along a surfaced road. In addition, there was a high-volume bilge pump that could eject 250 gallons a minute. This pump proved to be so efficient that even when DUKWs were holed repeatedly by enemy fire they often were able to remain afloat.

Proud of their new vehicle, the NDRC team took it to the Army Chief of Engineers in search of approval for a production order. To their surprise, they were turned down. The Chief of Engineers said the Army had no requirement for such a vehicle, even after it had performed successfully in demonstrations. To appreciate this rejection, one must recall that the Army was approached repeatedly by inventors and designers with ideas for wonder vehicles, single-purpose, highly specialized pieces of equipment alleged to be the solution to some pressing problem. With one eye on the long history of impractical devices submitted and another eye on anticipated complications imposed on maintenance and supply by the proliferation of special-purpose equipment, Army planners seemed to shy away instinctively from overwhelming difficulties.

Persistence Pays

The NDRC officials persisted, however, and finally persuaded the Quartermaster General to authorize a production order for 2,000 units. The designation DUKW, pronounced *duck*, bore no relation to the amphibious bird; it was just a coincidence. In General Motors parlance, *D* stood for 1942, *U* for utility, *K* for front-wheel drive, and *W* for two rear driving axles. Delivery was to begin in December 1942.

The first 25 production models were sent off to the four theater commanders for tests and trials to determine operational feasibility. All four reported the vehicle was not seaworthy. This came as a surprise to NDRC staffers since their earlier tests in gale-force winds at Cape Code had shown the DUKW to be remarkably stable, even in 10-foot waves, because of its low center of gravity and the heavy outboard weight of its wheels. Investigation revealed that the Army tests had been conducted by the various theater commanders with untrained crews.

The sponsors in NDRC had made an unavoidable tactical error in sending the DUKWs out for testing without making careful provision for proper crew training. They should have known better because a similar disaster had beset the earlier trials of their amphibious jeep when untrained drivers forgot to insert the bilge plugs before they entered the water, so they immediately foundered. Trained crews promptly were sent out to remedy the initial failure, and the DUKW quickly won converts by its versatility. It could carry 10 tons of cargo when afloat, even though its suspension system limited it to 4 tons on the road. To be sure, the vehicle made only 5 knots in the water, but it could do 50 miles per hour on a reasonable road on land. Its low profile in the water made it a difficult target to shoot at, a feature that made the DUKW attractive to its crewmembers.

Combat Performance

By the time the Allies launched their assault on Sicily in July 1943, more than a thousand DUKWs were available. In the landings on the Sicilian shore, they performed superbly. *Stars and Stripes* reported that the first Italians to see these amphibian monsters climb out of the water and roll across the beach surrendered out of sheer amazement.

In retrospect, personnel directing the assault on Sicily identified the DUKW as the most outstanding of the various novel items of equipment used there. It could transport a total of 36 men or 25 men and all their equipment as assault troops. When a DUKW returned from the beach laden with wounded, it could move right up inside a landing ship, tank (LST) to discharge its human burdens, eliminating the necessity for the painful handling required when litters have to be transferred in and out of small craft. In addition, the DUKW proved unexpectedly effective in towing beached vessels off the shoreline. Using the powered winch mounted on its stern, the DUKW also was able to pull palletized loads or cargo sleds across sandy beaches and above the waterline.

While NDRC officials had fully expected the success of the DUKW as a cargo shuttle, they were pleased to learn that the vehicle proved to be as useful tactically as it was logistically. The DUKWs, each armed with one hundred and twenty 4.5-inch rocket launchers, proved immensely effective in laying down a barrage of fire covering that crucial interval between the time offshore naval batteries must lift their fire and the moment the assault wave actually reaches the beach. Because rocket launchers with the plumes of flame were highly visible, they tended to draw whatever fire the defenders were able to

An amphibian truck maneuvers supplies to the beach. Note the smokescreen obscuring the freighter.

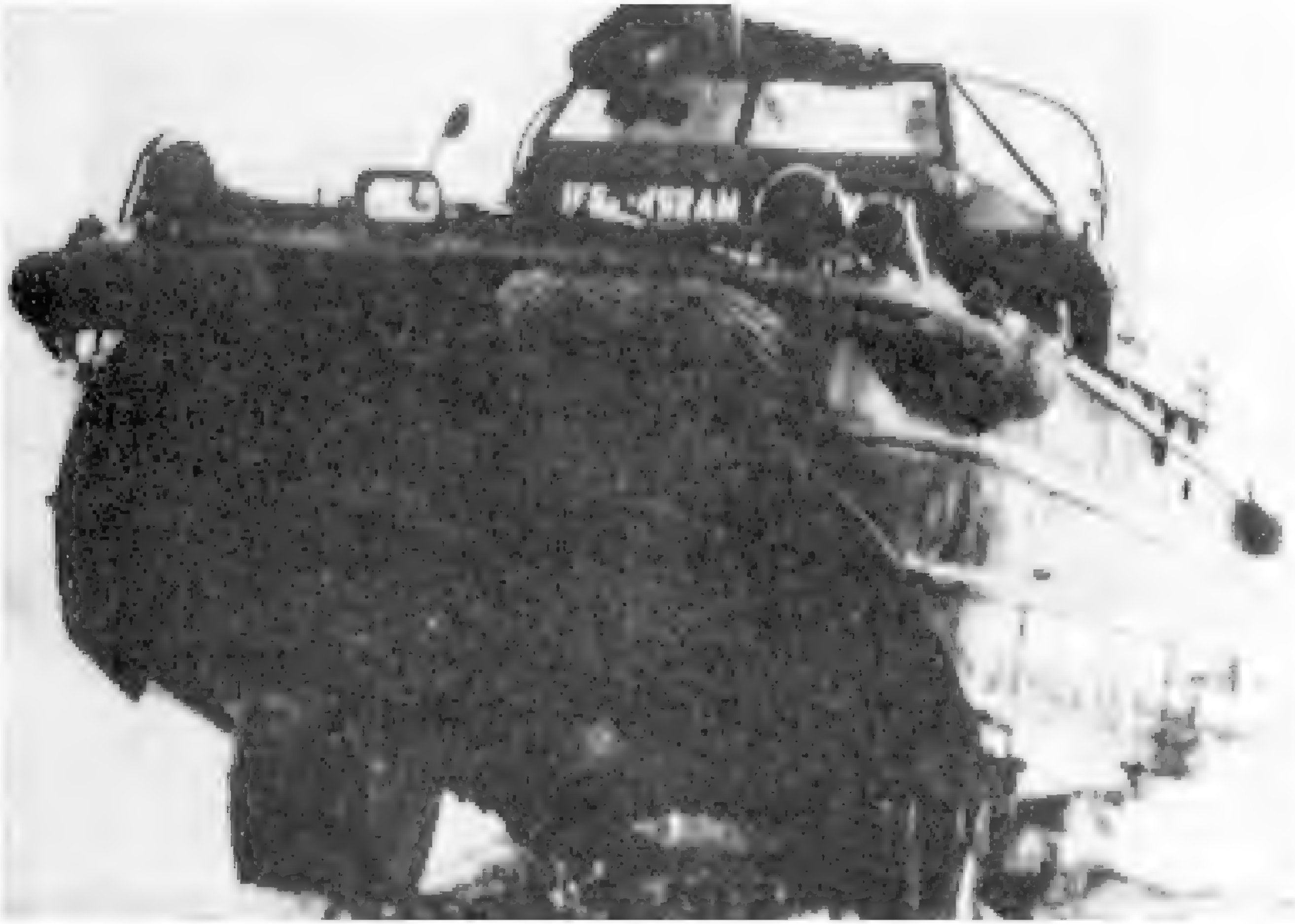
return, thus minimizing the attention devoted to those DUKWs carrying the attacking infantry.

Perhaps even more important tactically was the ability of the DUKW to transport 105-millimeter howitzers rapidly on shore. When equipped with an A-frame (one in every three units came with an A-frame as standard issue), a trained crew with two vehicles working in concert could offload a howitzer in 75 seconds. The strategic significance of this capability clearly was illustrated in Sicily. By providing effective artillery support close on the heels of the initial assault landings, Allied forces were able to blunt the counterattacks launched by enemy armored units. Without artillery support, lightly armed assault troops would have been at a decided disadvantage. When Army observers saw that the DUKW could land a 105-millimeter howitzer even when the surf was running waves 3- to 5-feet high, the strategic significance of the new vehicle was no longer in doubt.

A Problem of Definition

Logistical and tactical promise do not tell the whole story, however. Was the DUKW a boat or a truck? With considerable reason, the Navy contended that the vehicle was a small craft and, therefore, fell within the Navy jurisdiction. The Navy already had facilities to train boat handlers, so why should the Army duplicate this effort? The Army contended that the DUKW primarily was a truck and, therefore, within the Army jurisdiction.

On somewhat sounder grounds, the Army argued that the supply function performed by its amphibious engineer units was all of a piece, from initial offloading to inland supply point. One of the great virtues of the DUKW was its ability to drive beyond the beach to designated supply dumps inland, thus avoiding the beach congestion that characterized the landing of cargo from vessels at the shoreline. It would be absurd, argued Army officials, to divide jurisdiction at that point. This typical roles-and-missions dispute consumed several months and delayed a final decision on the organization of Army amphibious engineer units. Eventually, the Navy retained jurisdiction over all vessels more than 50 feet, while the Army could retain those under 50 feet. The DUKW was 31 feet long.



The Navy retained jurisdiction of vessels more than 50 feetin length, while the Army could maintain those under 50 feet. The DUKW was 31 feet long.

That the Services finally agreed on 50 feet as the jurisdictional dividing line, rather than 31 feet, was fortunate because a subsequent design change lengthened the DUKW to 36 feet in order to accommodate the three-quarter ton truck as cargo. This episode—which has its parallels in later jurisdictional disputes between the Army and the Air Force, based on the weights of aircraft such as the C-7 *Caribou* and various helicopters—would seem to suggest that *function* rather than *dimensions* should be employed in resolving interservice contention over roles and missions. The seeming simplicity of a precise dimensional specification too readily masks more fundamental issues that, until soundly resolved, will continue to exacerbate.

The DUKW was a weapon of great strategic importance. Its profound impact on the whole concept of amphibious assaults is attested over and over again. After the landings in Sicily, DUKWs were used in imaginative end runs around Kesselring's flank on the Italian peninsula when they put artillery units on shore by night to harass the German rear. More than 2,000 DUKWs took part in the invasion of Normandy. And in the Pacific, DUKWs helped make possible the successful assaults at Swajelein, Rabaul, and Okinawa, to name but a few of the more famous landings. By August 1945, 21,000 DUKWs had been procured, a number that gives testimony to the strategic significance of this relatively simple technological innovation.

In retrospect, three crucial elements stand out in the story of the DUKW. First, was the *creative imagination* of the people who conceived the possibilities to be exploited in an amphibious truck. The War Department files were full of proposals for amphibious trucks dating all the way back to World War I. Most of these involved sponsons or flotation gear that could be shed after landing. Some were serious proposals, some crackpot schemes, but good or bad, no one in authority seems to have taken the *concept* seriously until the NDRC team and its associated industrial designers developed a prototype DUKW. The second crucial factor was the persistence of NDRC in pushing the idea of an amphibious vehicle even when rebuffed by reluctant or skeptical military authorities. Finally, was the all-important training phase. Because NDRC failed to recognize the importance of adequate training before service tests, the whole project nearly was scuttled.

Dr I. B. Holley
In Margiotta and Sanders, *Technology, Strategy, and National Security*

(Continued from page 77)

surrounding the belief a single thrust offensive would have ended the war earlier, once the supplies were sufficiently in place, it became only a matter of time before Germany surrendered to better equipped military forces moving in from both east and west.

The logistics war in Europe involved developing a logistical base through the capture of developed ports, railways, and roads. The war in the Pacific presented a sharp contrast in the means of logistical support.

The Pacific

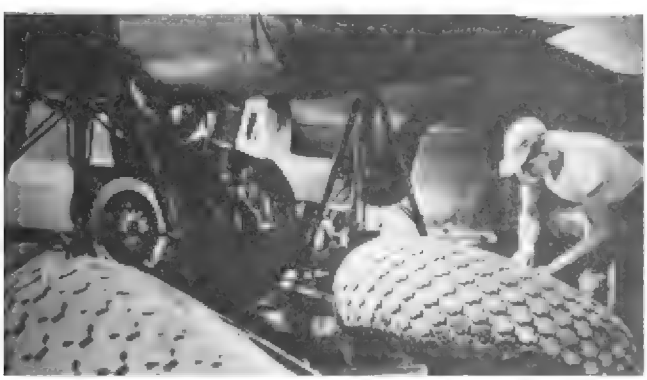
Like the war in Europe, the Pacific strategy was initially defensive: primary objectives were to secure lines of communication between the United States and Australia and to begin a supply buildup in preparation for future offensive campaigns. Much of the early Pacific efforts were hindered due to the *defeat Germany first* strategy of Allied forces. Besides a lower priority, the Pacific environment presented logistics problems that were very different from those in Europe and the Mediterranean. The first difference was distance; it was 7,200 nautical miles from San Francisco to the port in Australia, while the distance from New York to England or Africa was less than half of that. Additionally, distances were great between combat areas, with sealanes being the only available means for moving large numbers of men and equipment.

Another difference was the virtual nonexistence of inland transportation. Railway networks and highway systems, extensive in Europe, were foreign to most of the Pacific combat areas. Likewise, port facilities were undeveloped and, in most cases, nonexistent. Also, most logistical standard operating procedures, organizational setups, and equipment allowances were based on continental warfare experience and proved largely inappropriate in the Pacific (3:538).

These differences, combined with other difficulties—such as rapid deterioration of supplies due to climate, high rates of malaria, and lack of maps and terrain data—made the Pacific logistics problem very difficult. But perhaps the most

A B-29 armorer at Guam inserts a fuse into a 500-pound demolition bomb. B-29s carried up to 10 tons of bombs, compared to the 2 tons averaged by B-17 Flying Fortresses.

A B-29 receives engine care as it awaits a fresh load of 500-pound bombs.



A gross weight of more than 60 tons required substantial rubber between the runway and fuselage of the B-29.

Time to retire a Superfort.

significant logistics problems derived from the man-made environment of two services and commands (Army and Navy) conducting operations within the same theaters. The two services operated parallel supply lines with joint arrangements only for exploitation and local resources. In *Global Logistics and Strategy*, Coakely and Leighton show how "separate supply lines for two theaters and two services inevitably caused waste and duplication of effort in an area where facilities and resources were scarce" (1:391). The very fact that three different commanders could direct logistics in differing ways caused havoc for service forces trying to anticipate future needs. It also made the training of service forces nearly impossible—no one knew precisely what commanders expected of their logistics support. But again, as in the European theater, inefficiencies did not prevent effectiveness. The Pacific forces began receiving more equipment during the drawback on Bolero, and once they had the logistics advantage, it was only a matter of time until the defeat of Japan.

Still, the availability of supplies revealed the same fundamental logistics weakness that existed in Europe; beachheads quickly became congested because materiel arrived without markings and could not be forwarded to combat zones fast enough to keep pace with offloading. This all came about because of the low number and poor training of service troops. In the South Pacific theater, for example, there were only 14,500 service troops to about 92,000 air and ground combat troops. (1:413).

Because the Pacific environment was different, so were the types of equipment developed and used. Perhaps one of the major contributions to the art of warfare resulted from the experience gained in amphibious operations. Although based upon the experiences of the assaults in Europe and the Mediterranean, these operations matured in the Pacific theater (3:549). Two basic types of vessels were developed for amphibious warfare: combat loaders and various types of landing craft. Loaders, designed to carry specific types of equipment, would carry cargo as close to the beach as possible. Landing craft would generally drive their cargo right onto the beach. These vessels "quickly became so important that they were critical items of equipment throughout the war and . . . . Strategic decisions and the timing of major operations frequently hinged upon their availability" (3:549).

Although distributing materiel via enemy beachheads never became routine, effective procedures were eventually developed. By the time of the invasion of Okinawa, the last great battle before the atomic bomb was dropped, the Army and Navy had developed effective joint logistics procedures—far more efficient than at the start of the Pacific campaign. The close of World War II halted a huge buildup of supplies in Okinawa in preparation for the invasion of Japan.

In all, the logistics accomplishments of World War II were unparalleled in history. Many lessons were learned, but none were more important than the role logistics decisions and capabilities played in determining the outcome of global warfare.

Having reviewed the primary logistical factors of some of the major events of World War II, a closer investigation of the key logistics elements will prove beneficial, beginning with a look at the World War II industrial base.

Industrial Base

While prewar America clearly had the industrial capacity to supply and maintain a large army, industrial *potential* had yet to be converted into industrial *production*. All attempts by the War Department to ready industrial production prior to the war were disregarded; consequently, the United States relearned the fact that men can be mobilized more rapidly than equipment. The peacetime budgets of the Services were not increased until mid-1940 when Congress, following the German invasion of Norway, was shocked by the answer they received to an inquiry of military status. By the end of 1940, the President appointed various boards and committees for the purpose of investigating and coordinating national defense programs.

However, until the Japanese attack on Pearl Harbor, these actions had limited success because "defense efforts were controlled by the uncertainties of public opinion, and vigorous, positive administration was not possible so long as public policy was confused and objectives were not clearly understood" (6:5). Within weeks after Pearl Harbor, the War Production Board (WPB) was established to coordinate industries for national defense. The WPB was a civilian organization that possessed broad authority and through other agencies made decisions in areas of contracting, setting production priorities, and determining production limits. In some respects, the WPB resembled a *wartime congress*.

Industrial production in World War II was an *all-out* effort—the pace of production was initially guided by the President's *think big* challenge to produce "as much as possible of everything" (3:455). Industrial conversion and expansion was slow, and many of the same mistakes of World War I were repeated. The saving grace for the mobilization of industries, as mentioned earlier, was the fact that the Lend-Lease Act had already geared some industries toward production of weapons and materiel and had preserved England's and Russia's ability to continue fighting until US troops could be equipped. By 1943, industrial war production was in high gear, and well-supplied armies made rapid advances across France in 1944. Although overconfidence resulted in some premature munitions slowdowns, these problems were easily corrected. The requirements determination process, like the industrial base, was caught off guard at the outbreak of the war but, once begun, made great advances.

Requirements

A key organization formed to handle military logistics requirements was the Army Service Forces. This organization was formed at a top command level, on equal footing with the commanders of the Army Ground Forces and Army Air Forces, which shared equal responsibilities under the War Department (3:414). The major task of the Army Service Forces was to provide supplies and equipment for the Army at the place and

time and in the quantities required by strategic and operational plans (6:56). Naval and Army service activities remained segregated until joint service operations commenced in the Pacific.

ASF responsibilities were to determine detailed requirements; translate them into production factors; secure raw materials, industrial facilities, and manpower; ensure the end items were produced in accordance with schedules; store the items where they would be readily accessible without waste; and finally, deliver them to all parts of the world in the right quantities at the right time (6:56). However, once supplies were delivered to an overseas port, it became the theater commanders' responsibility to supply and service troops within the areas under their command (6:158). The Army Service Forces was very involved with determining service requirements.

President Roosevelt provided initial World War II requirements when he simply asked for "more of everything," but a program was still needed to coordinate the industrial effort with strategic plans and to provide guidance of both strategic and logistics planning (3:461).

Two basic assumptions guided requirements planning. First, supply should be adequate, and it was better to have too much than too little. Second, insofar as possible, supply should be automatic; that is., sent forward for use without requisitioning (later known as the *push* concept). Beginning steps involved determining the needs for initial supplies and replacements of damaged or worn-out items. Additional allowances had to be made for those supplies in the distribution system—whether at the warehouse, ports, in transit, or lost in transit due to enemy actions. The Army Service Forces developed plans that formed the basis for computing operational requirements for the first 18 months of the war. However, as theater commanders gained field experience, actions were implemented requiring commanders to submit estimates of operational requirements months in advance of their campaigns (6:59). Requirements standards for equipping troops were initially based on World War I statistics. However, these standards were quickly found lacking and were revised as more fighting experience was gained.

World War II was characterized by rapid changes, and these changes complicated the requirements process. Two cases in point illustrate the problem. First, the introduction of new equipment—tanks, aircraft, rockets, amphibious vehicles, landing craft, to name only a few—revolutionized warfare but also introduced new logistics problems (3:48). Each new item required that field commanders be provided full information on capabilities, while demonstration teams instructed others in their proper use. Standardization of maintenance requirements was to become a nightmare.

A second problem brought about by rapid change involved the identification and cancellation of programs no longer needed. For example, an ambitious program of seacoast artillery was ongoing long after the apparent threat to the US coast had disappeared (3:467). In all, although the requirements system in World War II got off to a slow start, it proved very effective. The acquisition process, on the other hand, not only was difficult to initiate but also experienced less certain results.

Acquisition

To make the best of industrial manufacturers, the US Government contracting and purchasing policies of competitive bidding had to be discarded, as did other laws and regulations that would tie up contracting in red tape (3:70; 7:468). However, putting aside peacetime restrictions by no means made the going easy. The military found it necessary to develop new restrictions to govern contracting:

> For a time, the new freedom in contracting imposed new restrictions as headquarters and agencies at various levels introduced their own restrictions to ensure themselves against charges of favoritism, collusion, or improper awards of contracts (3:469).

A far worse problem was that few within the War Department had the necessary experience to set prices with civilian manufacturers, and the large number of required contracts invited profiteers. Contracts were first made on a cost-plus-fixed-fee basis, closely followed by cost-plus-percentage-of-cost contracts. A policy of *progressive pricing* was introduced in 1943 before the company pricing program was instituted in mid-1944. These programs evolved as attempts to set accurate cost estimates for buying war materiel

End of Year	Total	Heavy Bombers	Medium & Light Bombers	Fighters	Reconnaissance Planes	Transports	Trainers	Communications
1939	2,546	39	738	492	378	131	761	7
1940	3,90961	92	639	625	404	124	2,069	8
1941	12,297	288	1,544	2,170	475	254	7,340	226
1942	33,304	2,079	3,757	5,303	468	1,857	17,044	2,796
1943	64,232	8,118	6,741	11,875	714	6,466	26,051	4,267
1944*	72,726	13,790	9,169	17,198	1,804	10,45	17,060	3,249
Aug 1945	63,745	13,390	8,463	16,799	1,971	9,561	9,588	3,433

*In July 1944, the AAF reached its peak of 79,908 aircraft on hand.

Airplanes on Hand in AAF by Major Type.

at prices fair to both the government and the manufacturer. A part of the final solution to price setting came with the appointments of leading business and professional men to the War Department Price Adjustment Board, resulting in a high degree of cooperation from industry (6:70).

New contracting procedures were not the only changes made in the acquisition arena. The number of contracts written during the first years of World War II brought about decentralized procurement responsibilities and actual contract negotiations (3:469). For example, technical service chiefs were authorized to award contracts that committed funds up to $5 million without coordinating with higher levels of authority. Initially, most contracts went to large firms when there was greater confidence in quick, large-scale production. But, because the Controlled Materiel Plan made it almost impossible for nonwar-producing industries to obtain steel, copper, and aluminum, small firms began to complain. Small firms were eventually to receive more than 25 percent of defense contracts, not including subcontracts made with larger firms. The *Small Business Act* of 1942 not only helped small business but also was the first step toward broadening the defense industrial production base (3:473).

Each of the six technical services of the Army Service Forces established a procurement organization different from the others. These services divided the United States into specific geographical districts and set up district offices to contract and purchase items needed for that technical service. However, the geographic basis for purchasing proved inefficient because the technical services were bidding against each other on numerous common items such as clothing, foods, shoes, and so forth. As the war progressed, the purchasing of materiel on a commodity, rather than geographical, basis became a more common practice. This system used service depots to deal with all the industry on specific items. Technical services could then acquire needed items from the depots, usually at much lower costs. Although neither the geographic nor the commodity basis for procurement was totally satisfactory during the war, the general trend was toward purchasing on a commodity basis (6:74).

Maintenance

With the overwhelming increase in motor vehicle and weapon usage during World War II, maintenance of these items became far more important than in previous wars. As in other logistical areas discussed thus far, ASF responsibilities for maintenance ended when supplies reached ports of debarkation. Once maintenance supplies were ashore, theater commanders were responsible for maintenance activities. This discussion of maintenance will center about two illustrative areas: motor vehicles and ordnance.

The production of new vehicles made the task of supplying spare parts and instructions almost impossible. In fact, some 330 different types of vehicles were in service during World War II. Fortunately, the 2-1/2-ton truck and the jeep constituted more than half of the nearly 2.4 million motor vehicles produced between 1940 and 1945, so problems of maintenance and spare parts were eased accordingly (3:480).

As significant as the spare parts problem was, another equally important problem was untrained and careless vehicle operators. Very little consideration had gone into educating vehicle users about the importance of preventive maintenance. Many major vehicle breakdowns could have been avoided with proper vehicle care. In fact, this maintenance shortcoming led to the eventual failure of the *Red Ball Express* (3:528). Consequently, the Army Service Forces was tasked to develop routine vehicle checklists, educational programs, standardized tool kits and vehicle equipment, and programs to control spare parts in an attempt to remedy maintenance problems.

Vehicle care presented only one part of the maintenance difficulties. Although most ordnance items proved very durable, supplying spare parts for damaged or worn weapons proved to be the biggest maintenance problem. In addition, maintenance procedures within combat theaters presented other difficulties.

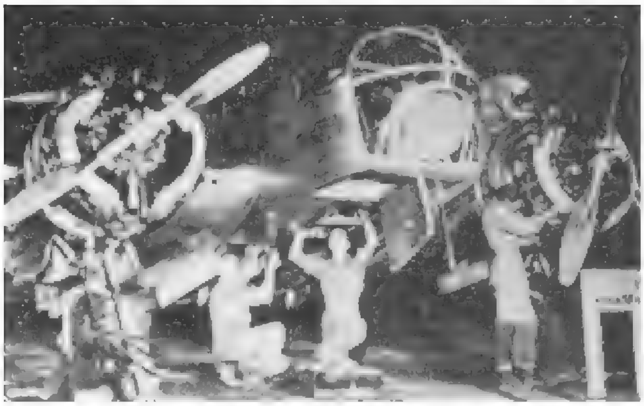
The maintenance of combat equipment for advancing armies presented a special problem. Although a few mechanics traveled with combat personnel in front lines, most of their capabilities were limited to malfunctions requiring only small part replacement or adjustment. Major repairs were performed by mobile maintenance crews in the field. Beyond this, vehicles were towed to rear area maintenance facilities. Aside from the expected problems of performing maintenance in field conditions—complicated by mud, bad weather, and parts shortages—cannibalized vehicles compounded the problem of getting equipment back into action.

Abandoned vehicles were common sights during combat operations. They often stopped running simply because of adjustment problems or other *easy fix* reasons. However, valuable spare parts were often removed from abandoned vehicles by other passing vehicle operators before maintenance crews arrived. Naturally, this situation greatly complicated the maintenance task of getting vehicles back in operation and returned to combat units. In time, most of these problems were reduced but never completely eliminated.

Without doubt, World War II presented enormous logistics problems and produced equally enormous solutions. The

(Continued on page 104)

Engine mechanics class, Randolph Field, Texas.

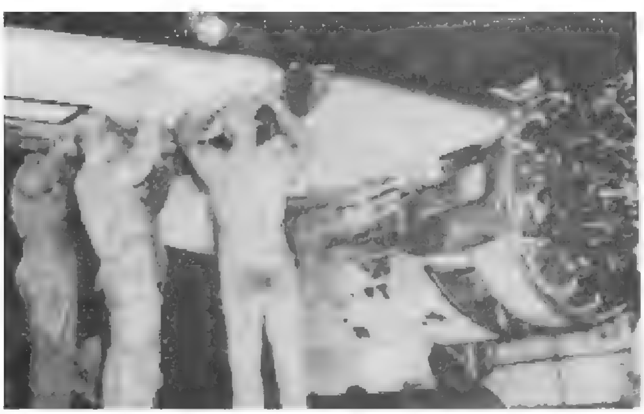


Aircraft postflight at the San Angelo Bombardier School, Texas.

Round-the-clock repair of B-24 Liberators at Ogden, Utah. Prior to the war, all types of aircraft were overhauled in accordance with a general set of instructions. Aircraft soon became too complex for this approach, and a new *Inspection and Maintenance Guide* was written for each Service.

A fighter engine receives a quick tune-up before carrying its 20-millimeter guns to the front. Prewar tests of the .50-caliber machinegun and 20-millimeter cannon contributed greatly to the striking power of aircraft such as the P-47 Thunderbolt.

Engine mechanic class, Randolph Field, Texas.



An Air Service Command combat maintenance team learns how to install a wing section.

Sheet metal workers of the 580th Services Squadron, 59th Service Group, repair flak damage to a bomber's wing.

The American World War Crusades reflected the militant Calvinism of the frontier Rifleman, Quaker pragmatism, and Cavalier ideas of honor. The American professional soldier did what his society wanted him to do as well as any professional man in history.

Theodore Ropp

Grand Strategy: Major Logistical Choices

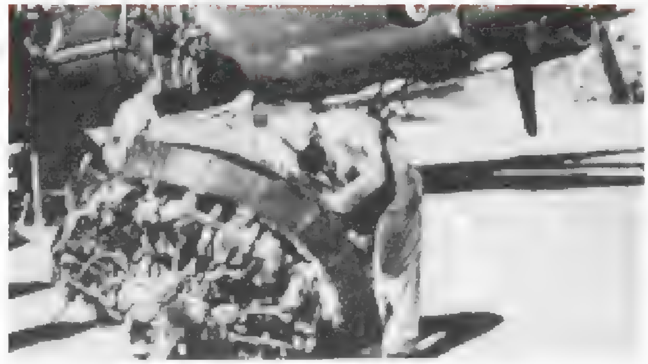
More important than the army's size, however, was its composition. It was to contain 61 armored divisions, nearly a third of the total and an altogether higher proportion than that present in the German, British, or Russian armies. Wedemeyer had been introduced to the idea of mass armored tactics at the Kriegsakademie; he had, like all professional soldiers, marvelled at their successful application in the 1940 blitzkrieg; he was determined that the United States should have the means to outblitzkrieg Germany when the time came. And so, unlike the British Army, which was building and training a host of small specialized units for raiding and diversion, the American Army, in Wedemeyer's plan, was to contain only three sorts of formation: armored divisions, a few airborne divisions to operate with them on the blitzkrieg pattern, and a mass of infantry divisions to consolidate the gains won by the tanks. It was, in short, to be an army suitable for only one sort of operation: large-scale, tank-infantry battles on the Continent of Europe. In a covering note, Wedemeyer revealed that intention and his own philosophy of battle in unequivocal terms:

> We must prepare to fight Germany by actually coming to grips with and defeating her ground forces and definitely breaking her will to combat . . . Air and sea forces will make important contributions, but effective and adequate ground forces must be available to close with and destroy the enemy inside his citadel.

Though a citizen of the most productive nation on earth and one with slack enough in its economy after 12 years of depression to display a breathtaking burst of industrial acceleration, Wedemeyer recognized that not even the United States was rich enough to disregard the most fundamental of all truths about strategy; that it is always a matter of choice. "He who defends everything," Frederick the Great used to warn his generals, "defends nothing." "He who attacks everywhere," Wedemeyer might have echoed, "attacks nowhere." The United States, though more than twice as populous as Germany, could not at the same time build an army large enough to fight a major war against the Japanese, wage peripheral operations around the coast of Europe, and attack the German heartland while still manning the factories that made her the arsenal of democracy. Since all else depended on their output, there would have to be economies elsewhere. The Japanese could not be ignored; the Germans *must* be brought to battle; therefore, the economies must be made in peripheral operations. But they could also be achieved by correct, early decisions about the way Germany was to be fought to a standstill while the Japanese were kept in play. A war in the Pacific must of necessity be amphibious, entailing the creation of expensive amphibious task forces.

John Keegan
Six Armies in Normandy

Operation Chowhound



In August 1944, the Director of Operations for the Eighth Air Force asked the Office of Armament and Ordnance to "design, develop, and test a simple device for carrying food in the bomb bay of a B-17," the food to be dropped "over prisoner of war camps in Germany." Thus was born the second of eight specialized World War II operations of the Eighth Air Force. Ironically, because of the rapid Allied advances in western Europe, no food would be dropped to POWs; rather, the Eighth Air Force *Flying Fortresses* would later perform evacuation flights to return the American prisoners of war. Food drops, Allied officials determined, would instead be made over occupied Holland to forestall mass starvation among Dutch citizens. The code name selected for this mercy mission: Operation Chowhound.

Operation Chowhound and its British counterpart, Operation Manna, probably would not have been conducted except for a special *food drop truce* reached between the German forces occupying western Holland and the Allied forces that faced them. Operation Manna, which involved hundreds of RAF Lancaster (four-engine) bombers, actually overlapped conditions hampering operations on given days at the various Allied airbases in England during late April, early May 1945. Manna began on 28 April and concluded with a final mission on VE Day, 8 May. The RAF crews flew a total of 3,341 sorties in 8 days during that 11-day period, dropping 11,679 tons of food over western Holland. The British Air Staff described Manna as "a fitting commentary on the flexibility of airpower."

Harold F. Nufer
Aerospace Historian, Spring 1985

The Duffle Bag

In the early days of World War II, each soldier was issued two blue cotton denim bags in which to stow every item of his gear. This bag originally designed in World War I, was standardized in 1929. The barracks bag, as it was called, could be secured with rope, a woven cotton *clothesline*, entering brass grommets at the top of each sack. To carry the two barracks bags when fully laden, one tied the two rope closures together and swung the bags fore and aft over one's shoulder, pannier fashion. The ropes cut cruelly into the shoulder or collarbone, and the bags bounced as one walked. Fatigue set in quickly if one were required to march any distance with this awkward load. All in all, barracks bags made good laundry containers but a poor means for transporting personal gear.

Rather late in the war, in April 1943, the Quartermaster finally issued a duffel bag made of heavy canvas or duck, waterproofed, and doubly reinforced on its bottom. A staple and three grommets provided a secure closure that could be padlocked. But the best feature of all was a wide carrying strap of webbing with a snap hook with which to effect closure at the neck of the bag in the absence of a padlock. This bag would hold at least half again as much as a barracks bag, and one could carry it with comparative comfort for long distances with little fatigue. Unfortunately, because of wartime shortages of duck, only a limited number could be procured.

Admittedly, the cost of the duffel bag may have ruled it out during the impecunious prewar years. But surely the Quartermaster's designers could have sewn a broad cotton band on the side of the cotton barracks bag to permit the user to carry it slung over the shoulder or over two as a knapsack. The failure, one suspects, was a lack of imagination rather than want of funds. As the editor of the *Royal United Service Institution Journal* remarked not long since, "Good Quartermasters may win more battles than brilliant tacticians by providing creature comforts which boost morale." To this sentiment, old soldiers who have shivered all night on the hard ground with nothing but a poncho and a blanket certainly will say "Amen," while praising those who introduced the lightweight, insulated sleeping bag. Well-rested troops have a strategic significance that should never be overlooked. A similar sentiment surely must be extended to those who evolved the jungle hammock with its lightweight net body, mosquito bar, and waterproof roof or cover, making feasible military operations in otherwise impossible jungle areas.

Dr I. B. Holley
In Marigotta and Sanders, *Technology, Strategy, and National Security*

The Logistics Snowball

The most important principle is that of *The Logistics Snowball.* This principle states that all logistics activities naturally tend to grow to inordinate size, and unless positive control is maintained, this growth continues until, like a ball of wet snow, a huge accumulation of slush obscures the hard core of essential combat support, and the mass becomes unmanageable. This snowball effect permeates the entire structure of military organization and effort.

It applies both to personnel and materiel, and it is both interacting and regenerative. It is similar to the concept of a chain reaction and to Parkinson's Law.

The logistics snowball is particularly dangerous and expensive in overseas operations, especially in time of combat. Here the *unnecessary supplies and personnel block the flow of the necessary resources. Thus, it directly damages combat effectiveness*.

The indirect effects, however, spread throughout the entire military system by increasing every functional element of logistics. Thus transportation, supply storage, procurement activities, housing, training, and hospitalization must all be increased because the snowball is regenerative and contagious. There are even further effects, for planning slows down, and planning staffs increase.

But as personnel requirements mount, *the quality of personnel that can be obtained decreases, thus adding mediocrity to the other snowball effects*. As this continues, professional competence decreases in all areas, and size rather than quality tends to become the criterion by which organization and installations are judged. *The ultimate effect is that the quality of major decisions is reduced*. This a major factor in explaining why the Pentagon is too small to house that part of the Department of Defense located in Washington.

The application of logistics discipline is the foundation for all control of the snowball. Logistics discipline, while closely related to general military discipline and to supply discipline, is more specific than the former and more general than the latter. One of the anomalies of World War II was that senior officers who would not tolerate insubordination in normal matters or in the conduct of tactical affairs frequently recklessly violated *logistics* orders themselves.

Rear Admiral Henry E. Eccles
Military Concepts and Philosophy, 1965

This is not a war of ammunition, tanks, guns, and trucks alone. It is as much a war of replenishing spare parts to keep them in combat as it is a war of major equipment.

Ernie Pyle, Newspaper Correspondent

Balancing *Teeth* with *Tail*—Two Views

Almost never will all logistics requirements be satisfied in exact balance, and as long as this is true and as long as military operations are governed by the finite, some phase of logistics is bound to be the limiting factor. It, therefore, would serve no useful purpose to isolate one element of logistics and show that it limited the scope of possible military operations unless it could also be shown that all other logistical requirements could have been met to support the operations in question.

Perhaps the general problem from which it was most difficult to draw definite conclusions was the question of personnel to perform all the logistical functions needed It has become common to make the ratio of combat troops the measure of efficiency in the Army. By itself, this ratio may mean nothing. The important factor is the total amount of effective firepower that can be brought to bear against the enemy. If the greatest total effective power can be delivered with one combat man for each serviceman, then this is the desirable ratio; but if 1,000 service troops for one combat man are needed to achieve that maximum, then that is the desirable ratio.

Much to their consternation, a great many old soldiers who longed for the smell of gunpowder and the chatter of machineguns faced the more likely prospect of having to settle for the smell of mimeograph ink and the chatter of typewriters. Officers and men who felt they were contributing nothing to a war effort if they were not on the firing line had to develop a broader view of the requirements of modern war.

Most of the Army was not in the combat arms—the infantry, armor, and artillery—most of it was in the technical services—the engineers, quartermasters, medics, administrative services, and the headquarters that guided and supervised the tactical and service units from the combat zone to the Pentagon.

James A Huston, *The Sinews of War*

The problem of balance applied with equal force to the troop basis. The objective at all times, of course, was to maintain the highest possible ratio of combat service forces in order to achieve the greatest possible combat potential. The War Department, always fearful that the theater might become top-heavy in service troops, never stopped urging the theater to *comb its tail* and *sharpen its teeth*. The ratio naturally will vary with circumstances. Combat commanders, although recognizing that developments in warfare of the last century have reduced the proportion of a total force that can be put into the front line, never ceased to demand a larger slice of the total manpower allocation, as was evidenced in the premature acceleration of the divisional buildup on the Continent in the late summer and fall of 1944. Within the Communications Zone, meanwhile, each technical service, concerned primarily with its own mission and desirous of providing perfect service, naturally tended to exaggerate its own needs and asked for the largest slice of the manpower pie that it could justify. The sum total of minimum requirements invariably exceeded the authorized troop ceiling. Resolving such conflicting demands usually calls for an arbitrary decision. Unfortunately, the wisdom of allocation must always await the test of operations.

Roland G. Ruppenthal
Logistical Support of the Armies

Cold Weather Lessons Relearned

It could only have been in total ignorance of the Arkhangelsk campaign, more than 22 years earlier, that the German Army in 1941 could be *surprised* (as General Rendulic expressed it) that because of the extreme cold the mechanisms of rifles and machineguns and even the breech blocks of artillery became absolutely rigid. The recoil liquid in artillery pieces also froze stiff, and tempered steel parts cracked. Strikers and striker springs broke like glass.

Soviet weapons were designed for winter, and they used appropriate lubricants. The Germans preferred the Soviet submachinegun to the model originally issued to them. During the first winter, the Germans had to improvise by lighting fires under their artillery and either wiping off all the lubricants from weapons or experimenting with substitutes. Kerosene worked, but it was not durable and had to be renewed frequently. Sunflower oil proved quite effective, but it was available only in Southern Russia.

Dr Allen F. Chew
Leavenworth Papers (No 5)

Strange as it may seem, the Air Force, except in the air, is the least mobile of all the Services. A squadron can reach its destination in a few hours, but its establishment, depots, fuel, spare parts, and workshops take many weeks, and even months, to develop.

Winston Churchill,
***Their Finest Hour,* 1949**

(Continued from page 98)

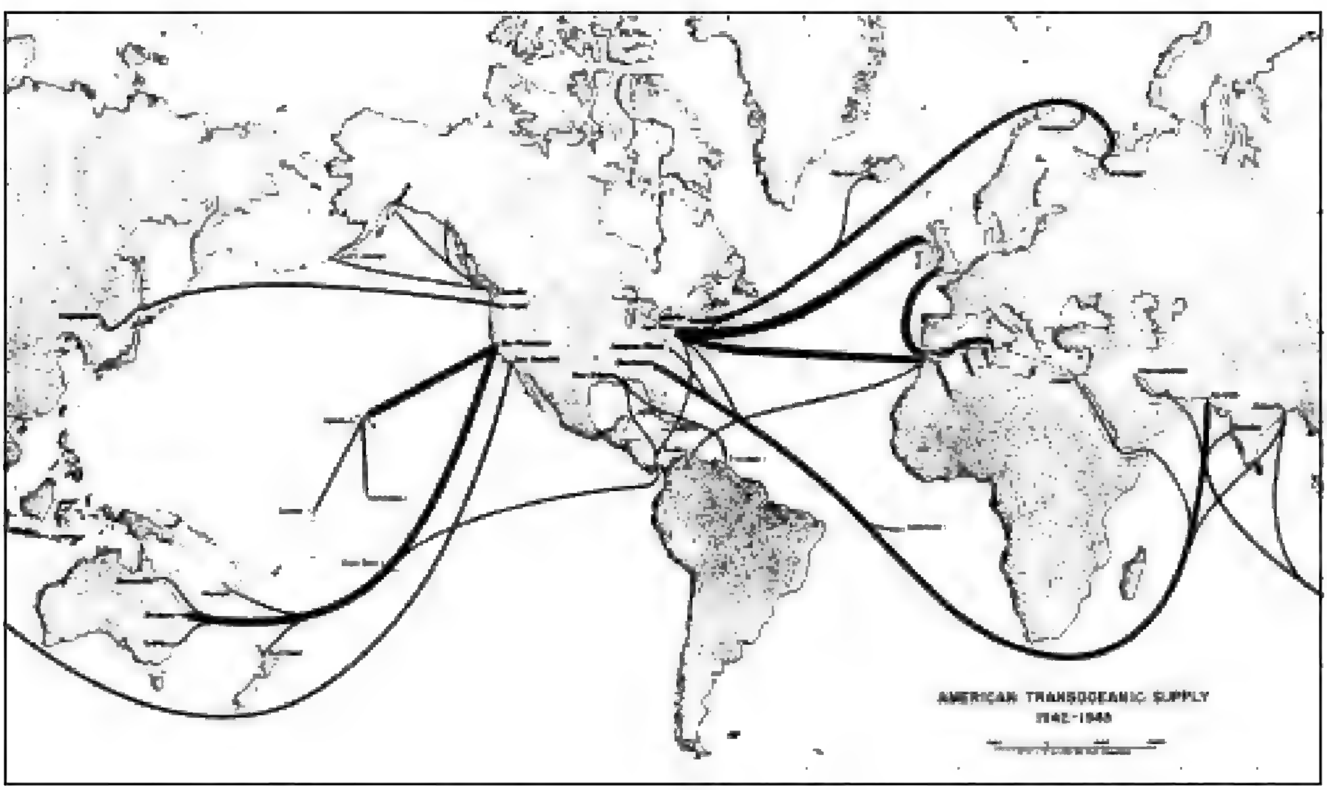
magnitude of the logistics effort was unequalled in history, and many of the procedures developed would again be used in America's next wartime challenge—the Korean War.

Distribution

Major objectives of logistics go beyond the acquisition of supplies and equipment. Successful logistics requires these products be placed into the hands of combat forces and everything be moved into battle areas. The tremendous global distances that lay between US industries and the battle areas of World War II were an advantage to both the Germans and Japanese. Germany, because of her secure grip on the coastal ports of Europe, was confident that no major army could be supplied without access to these ports. Furthermore, German plans specified the destruction of port facilities as a defensive tactic to prevent a major Allied offensive (2:245). At the time of this decision, the Germans were probably correct; special landing craft, now so familiar, had not yet been designed. But like many things in World War II, distribution consisted of little planning combined with loads of ingenuity. Before describing some of the vehicles developed to carry the means of war to the front lines, we will first look at the development of the distribution system.

The distribution process began when factories or depots placed items on trucks or trains for delivery to the east or west coast ports of embarkation. Supplies were moved, according to priority, by ship to one of several overseas ports of debarkation. As was earlier mentioned, theater commanders were in charge of getting supplies to the forces in their areas. As described by James Huston in *The Sinews of War*, "Responsibility for supply extended down the chain of command from the theater commander to the smallest unit commander; each was responsible for the supply of troops within his own command" (3:502). The movement of bulk supplies from the coast to combat forces was controlled through a series of communications zones (ComZ), which were directed by an organization called the Services of Supply (SOS). The Army Air Forces developed a separate system for supply and movement of aviation materiel. In spite of the apparent simplicity of this system, the real challenge came in coordinating all the factors needed to make it work smoothly.

At first, automatic supply was used to control distribution, but because stateside planners could not determine the strength and composition of overseas forces, unbalanced stocks and large reserves were piling up at overseas ports (9:47). Automatic supply worked well for established bases that consumed supplies at a fairly constant rate, but a semiautomatic system proved to work much better for task forces involved in mobile or flexible combat operations. Under this system, controlled items, such as ammunition and gasoline, would be delivered according to information supplied by commanders on materiel status reports. Other supplies depended on standard requisitioning (9:47). This semiautomatic supply remained the primary system from 1943 to the end of the war.



Since the European and Pacific theaters faced such different distribution problems, separate discussions are presented.

Distribution in Europe

The major distribution factors involved in the invasion of Europe centered around rapid offloading and turnaround of ships on the beaches of Normandy and the quick removal of equipment from coastlines to prevent the bottleneck situations experienced in the North African invasions.

To facilitate rapid offloading at beachheads, two floating docks called *Mulberries* were constructed in England and positioned on the French coast. These docks were capable of offloading both smaller landing craft and larger ships. Despite the Allies' failure to capture the major port of Cherbourg within the first week of fighting as planned and the destruction of the Mulberry docks in a storm 13 days after the invasion began, the floating docks enabled the offloading of major pieces of equipment needed to establish a firm beachhead in Europe. However, movement of equipment from the beaches to the combat troops proved a bit more difficult.

Two events early in the invasion presented serious problems for the communications zone, which was tasked to move the supplies inland. First was the delayed capture of Cherbourg, and second was the unexpected breakthrough and pursuit by the Allied armies across France. A bottleneck of ships formed in the channel waiting to offload supplies. Consequently, these ships became floating storehouses for a time. This slowdown of supply movement contributed to the inability of the communications zone to keep up with the armies as they took advantage of the early, unexpected breakthroughs. The primary problem with the communications zone was one of organization. Confusion existed between the Chief of Transportation and the ComZ staff as to who was in charge of movement control. The problem was finally solved when the Chief of Transportation was given full responsibility for all movement control (9:50; 8:21221).

Significantly, the saving grace of the European invasion was the ability of specially designed landing craft and ships to offload equipment directly on the beach. This capability prevented the stagnation of equipment distribution during the earliest phases of the invasion. The Allies themselves were surprised at the quantity of goods that could be landed over the beaches, and this type of unloading continued as a major activity far beyond the time originally planned (3:525).

Distribution in the Pacific

The Pacific war presented distribution problems that differed from those of Europe. Continental distribution procedures were largely inappropriate for a war that island hopped over great distances of water. Furthermore, there were none of the extensive railway and road networks that characterized European countries. These factors almost forced service branches into close contact throughout the Pacific war. Still, interservice distrust prevented full integration of logistics support (3:540). Consequently, Army and Navy supply agencies duplicated each other's efforts, resulting in wasted resources at a time when economy was a critical factor.

Unlike the European theater, where intermediate depots were established within the communications zone to distribute supplies to forward areas, the Pacific Islands were scattered over distances to great to make intermediate or local distribution practical. As a result, direct shipments were made from the United States to many individual destinations in the Pacific. Since distances were so great, a new means of shipping was developed to make direct shipments more effective.

B*lock loading* quickly became the standard shipping procedure. Based on experience factors, a block was made up according to the requirements for a given number of men over a number of days. Materials packaged within the blocks followed two patterns. One block contained all types of supplies needed during the early phases of a task operation, while the other block contained only one class of supply. Using this system, theater commanders could order standard blocks of supplies and designate when and where the delivery was to be made. Of course, this system did have difficulties and still relied on local purchase of some items, but its flexibility proved suitable for Pacific operations.

As in Europe, an insufficient number of service troops, combined with inadequate facilities for offloading ships, caused bottlenecks to occur and was probably the cause of most logistical problems in the Pacific (3:543). Furthermore, once the supplies were ashore, the task of moving them forward was hampered by weather, terrain, and lack of roads. Often, naval and amphibious vessels were used to distribute inland, and in many cases, supplies had to be airdropped.

Perhaps one of the most ingenious methods of naval distribution in the Pacific was the *Mobile Drydock,* which delivered fuel, ammunition, provisions, other supplies, and repair facilities afloat to fleet ships deployed to forward regions. This innovation provided fleets the *long legs* needed to move and maneuver almost indefinitely without returning to fixed advanced bases. The decentralized methods of distribution used by naval commanders may have proved more readily adaptable to island warfare than did the Army system of centralized control and an orderly distribution system (3:540).

In all, the accomplishments made in distributing men and materiel during World War II far outweigh the deficiencies noted. Tremendous numbers of men and amounts of equipment were moved to battlefields as far as 6,000 miles from US shores. The US Army and Navy successfully waged war as had no other military force in history.

The Korean Conflict

When war broke out in Korea, the North Koreans held a distinct logistics advantage over the Republic of Korea (ROK) in that all major industries were located in the North. Additionally, a major portion of ROK military equipment was captured during the first days of fighting and placed in use by the enemy. So once again, the United States was faced with supplying war

(Continued on page 119)

Automatic Resupply Versus Requisitions

Automatic supply was used throughout most of 1942, but the United States began to shift to a requisition system as it became evident that unbalanced stocks and large reserves were accumulating in several overseas areas. Neither method was satisfactory in situations where there was a shortage of required items or where information was incomplete. The greatest difficulty in meeting requirements for automatic supply was in determining the strength and composition of the forces being supplied. To improve control, in March 1942, the War Department instituted a materiel status report, to be submitted monthly by overseas commanders, listing quantities of selected scarce items on hand and authorized. The War Department intended the report to serve as a requisition, but because of difficulties in eliminating overlapping reports of shortages and in correlating successive reports, the system did not work as planned.

In the fall of 1943, a new system of supply and control was adopted. It was based on the assumption that overseas supply would develop in three successive phases. During the first, all supply would be automatic. This would continue until the second phase (considered the normal phase) when procedures would become semiautomatic; the provision of controlled items and ammunition would be based on status reports, other supplies would depend on requisition. In the third phase, which was expected to occur considerably later, supply would be entirely by requisition. In actual operation, a system similar to the second phase, with both automatic and requisitioned resupply, continued in use until the end of the war. This system was not without problems. Serious discrepancies between port records and figures supplied by the theaters were common, theater inventories were seldom adequate, and the time lag made status reports out of date before supply action could be taken on them.

Movement Control in Three Wars: World War II, Korea, Vietnam by Historical Division, Joint Secretariat, Joint Chiefs of Staff

Push and Pull in World War II

In 1942, a *push* distribution was used to supply materiel to the European theater, but because of excesses in some units and shortages in others, the United States changed to a requisitioning system. However, the requisitioning approach in turn developed problems because of the lack of a *real time* information system to transmit user needs to suppliers. Monthly status reports from commanders were programmed to serve as requisition notices, but due to "difficulties in eliminating overlapping reports of shortages, this requisitioning system also failed to work as planned" (2:2). Therefore, our forces developed a combined push-pull distribution approach for the remainder of the war. Despite this change, inaccuracies in inventory records and inadequacies in physical inventories persisted for the war's duration (2:2). Although the Allies had distribution problems, their ability to provide supplies and equipment to combat forces did surpass that of the enemy. Nevertheless, it is important for Air Force planners and logisticians to remember that the United States cannot afford to be as inefficient in future contingencies as it was in World War II. Since that war, technological progress in transportation, communication, and information systems alone has greatly improved the distribution of materiel. On the other hand, the enemy threat continues to increase the overall demand on this advancing technology; hence, there will always be a need to improve the distribution approach.

Although distribution of materiel suffered from many problems during World War II, an innovation termed *block loading* within the Pacific Ocean area deserves mentioning as a precursor for stockage planning and other important logistics programs. In the block approach, as explained by the Joint Secretariat Historical Division, "The theater determined a standard block of supplies needed to support a certain number of men for a given time period" (2:11). The blocks included either all categories of supplies (early phase) or only a certain class of supplies (resupply). "Under this concept the theater commander could order so many standard blocks or so many restocks of given classes to be delivered to any designated advance base" (2:11). The block approach established a standardized forecasting method and provided some success.

On the other hand, difficulties resulted from the inability to precisely define actual line item and unit requirements. The Director of the Service, Supply, and Procurement Division of the War Department alluded to this problem in comments he made about inventory management:

> Perhaps the greatest single deficiency in overseas supply systems was the lack of adequate stock control . . . . The Army Service Forces endeavored to maintain stated inventories in the theaters equal to 50 to 120 days supply. Such stock levels were almost meaningless without accurate consumptions and inventory records. There was no uniformity between theaters, or even between Technical services within a theater, in maintaining records of supply levels or of using these records in the preparation of requisitions. The supply information transmitted to the United States often contained many important errors . . . . There were occasions when duplicate requisitions were sent to the United States for supplies that, according to ASF records, had been delivered to a theater some time previously (1:169).

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Major Gary F. Hollums
USAF, "Distribution Approaches: A History and a Suggestion," *Air Force Journal of Logistics*, Fall, 1984

Innovation: *Small* Breakthroughs Spur Great Advantage

The Jerry Can

Before the outbreak of World War II, the Army planned to rely on the standard 55-gallon drum for distributing gasoline in the field. The container was totally unsatisfactory for effective use in combat, too heavy to manhandle, too big for pouring conveniently, and therefore, virtually demanding the use of a pump. Fortunately, with the help of British intelligence reports on their encounters with the German Afrika Corps in North Africa, the Army learned about the jerry can, which, as its name implied, had been developed by the Germans.

The jerry can was a well-engineered product. It was sturdy to stand hard use and had handles cleverly contrived to permit comfortable carrying by one man or two. The US Army copied the can but, in the process, tried to improve on the initial design by adding a detachable spout that would reach deep into armored vehicles to the buried fuel-tank aperture. Because the spout was not well engineered and tended to break off or get lost, soldiers fueling vehicles with jerry cans tended to splash gasoline into the opening with considerable spillage and waste. The Germans had solved this problem by simple expedient equipping of each vehicle with a large funnel.

When US troops stormed into France in Operation Overlord, the plan was to operate on the principle of *no can, no gas.* Each driver had to turn in an empty can to receive a full one. This nice theory broke down almost immediately as undisciplined troops scattered jerry cans across the French countryside. In no time at all, there was an acute shortage of jerry cans, despite the fact that the Quartermaster had ordered more than 18 million of them. The wasteful practice of heedlessly discarding jerry cans was all the more regrettable because the can had to be fabricated from expensive 20-gauge steel in contrast to the cheaper and more readily available 16-gauge steel normally used for 55-gallon drums.

By early September 1944, Patton's Third Army virtually was stalled in its pursuit of the retreating Germans for want of gasoline. Desperate, some of Patton's troopers hijacked a convoy of *Red Ball Express* trucks bringing up ammunition and commandeered the accompanying tank trucks carrying gasoline for the return trip of the convoy. The obvious result was to strand the whole convoy at the front further disrupting the flow of supplies. To remedy this situation, the Eighth Air Force had to divert B-24 bombers from their strategic missions to fly bulk loads of gasoline to forward airstrips, from where the gasoline could be picked up by Third Army units using their organic equipment. This was a highly expensive way to deliver fuel, not to mention the diversion of heavy bombers from the proper strategic use.

To recover some of the empty jerry cans, the Army launched a propaganda campaign and offered prizes to French school children for bringing in cans. This produced more than a million usable empties. Investigation revealed that US soldiers were not only just tossing aside empties but also misusing them in hundreds of ways, such as making stepping stones through the mud in a bivouac area, for example. These examples suggest that, in the equation of technology and strategy, troop discipline is an important factor that cannot be ignored.

The jerry can proved to be the vital link between the giving and receiving ends of the fuel supply. The giving end often was tankers in harbors pumping gas into tank trucks or the PLUTO (pipe line under the ocean), a not-too-successful scheme for pumping fuel from storage in England through cross-channel tubes or from pipelines laid across France, as much as 70 miles in a day when the pipe was available, which it often was not. Whatever the source of bulk fuels, the jerry can served as a highly portable and tactically flexible method of distribution at the cutting edge of battle. It helped, along with C and K-rations, the advancing US armies to sustain pressure on the Germans. The magnitude of this achievement perhaps is best reflected in a single statistic—by October 1944, the fuel supply system was delivering more than a million and a half gallons of standard motor vehicle fuel *each day* to the advancing armies.

Dr I. B. Holley
In Margiotta and Sanders, *Technology, Strategy, and National Security*

Military Birth of Operations Research

Operations research (OR) was born in the Royal Air Force. When war began in 1939, A. P. Rowe, Superintendent at Bawdsey Research Station, and Wing Commander R. Hart assembled the first formal OR section at Headquarters RAF Fighter Command. Initially, the group faced the problems of integrating the newly developed radar and the older Observation Corps methods of early warning of enemy air attack. Through experimentation and observation, the research section not only identified weaknesses in the system and recommended ways of improving radar operator techniques but also completed a comprehensive analysis of all phases of night operations and worked out tactics that played a decisive part in the Battle of Britain.

In August 1940, General Pile, Commander in Chief of the Antiaircraft Command, asked for help in the operational coordination of radar sets and antiaircraft guns. P. M. S. Blackett, noted British physicist and Nobel laureate, brought together a small group of scientists to study the problem. *Blackett's Circus* consisted of physiologists, mathematicians, physicists, an astronomer, a surveyor, and an Army officer. It was one of the first groups to recognize the need for close integration of scientists and service operational staffs and emphasize the use of the analogical process of OR to ensure service command objectives and doctrines were applicable to the problems at hand. *Blackett's Circus* was the start of OR in the British Army.

Operations research units spread rapidly. Blackett formed an OR section at RAF Coastal Command in March 1941. This section determined optimal depth charge settings and developed tactics for radar detection ships and submarines. In December 1941, Blackett was appointed Director of Naval Operational Research at the Admiralty, and OR was started in the Royal Navy. A study of optimal convoy size resulted in logistics support essential to an Allied victory. By the time the United States entered the war, OR sections were active in all three British services.

In addition to his direct involvement in the start of OR organizations, Blackett hastened their spread by writing the first comprehensive expositions of OR. He wrote *Scientists at the Operational Level* in 1941 and, later, *A Note on Certain Aspects of the Methodology of Operational Research*. These writings stated clearly what OR was and what it should do. Although secret, the documents received wide distribution and played an important role in the formation of OR groups in the three British services and in the Australian, Canadian, Free French, and US forces.

As it had in Great Britain, OR spread rapidly in the US military. The first formal OR group was started at the Naval Ordnance Laboratory in March 1942. Before even being formally established, the group played a crucial role in the widespread aerial mining of Japanese-controlled waters. In October 1942, General Arnold recommended all commanding generals of Air Force commands begin operational analysis groups. Based on Air Force experience, General Marshall encouraged all theater commanders to start similar groups to study amphibious and ground operations. By the end of the war, OR teams had made countless contributions that included major roles in the aerial campaign against Germany and in the campaign in the Pacific.

Lieutenant Colonel James A. Hoskins
"From the Wasteland of Experts—Back Through the Gateway of Competitive Examination," *Air Force Journal of Logistics*, Fall 1985

Uncertain Oil Supplies—1944

In this era of rapid technological development, new compelling factors arise every generation or so. We have noted how the Haber process enabled Germany to start World War I. In the 1930s, German revengers found themselves up against a new problem. Mechanization of all arms was proceeding apace, the air arm was coming into its own, and the internal-combustion engine dominated the whole scene of war. So it was essential for the warmongers to ensure a local supply of gasoline, which would render Germany, at least in part, independent of imported fuel. In fact, it was a *sine qua non* for the launching of a new war and the satisfaction of the demon that rides the German people. The warlords, therefore, set I. G. Farben to work once more and, with state funds, built up a series of immense plants for producing synthetic gasoline. The biggest of them all, the Poitz plant near Stettin, was constructed by the German subsidiary of Standard Oil at a cost of $80 million and was only completed in the first months of this war. In this way, the Reichswehr was enabled to keep peace with the growing mechanization of the tools of war, and the fear of an oil shortage no longer acted as a check on Hitler and the Prussians behind him.

Murray Harris, *The Logic of War*, 1944

Combat Rations

A few halfhearted experiments were made with compact rations in the 1930s. But no serious effort was made in this direction until 1940 after the outbreak of war in Europe. The excuse that research funds generally were unavailable was not entirely valid, because when Quartermaster officers finally addressed the problem in the 1940s, they discovered that a number of food processors were willing to experiment at their own expense in the hope of securing large production orders at some future time. Even then, however, practical combat rations were slow to appear.

Admittedly, Army standards were high, prudently so, and therefore, difficult to meet. Combat rations had to be able to withstand months of storage under a wide range of environmental conditions—baking under a tropical sun for weeks on end, for example. The same rations had to be able to withstand repeated freezings and thawings when stored in the open and still remain palatable. Some of the Quartermaster specifications, though logistical, proved to be unrealistic. One such was the stipulation that the rations had to be packed in tinned containers with squared corners, like a sardine can, to permit more compact and efficient packaging. It turned out, however, that only one or two firms in the entire United States had machinery to pack such tins. So the Army backed away from this particular requirement.

Eventually, the Army devised a whole array of combat rations. Terms such as *C-rations, K's, D-bars*, and *Ten-in-Ones* have become commonplace, even among civilians who learned them when millions of these rations were released on the open market as surplus after World War II. And these rations made all the difference, strategically, in the breakout and pursuit across France after successful landings of Allied forces in Operation Overlord across the beaches at Normandy.

When General Patton's Third Army was racing across France, pressing hard after the retreating Germans, his armored columns soon outstripped the capacity of their supply system, which had to concentrate on bringing up gasoline and ammunition rather than bulky conventional rations. Without the compact rations, Patton's troops never could have sustained the pressure on the retreating Germans. The Nazi generals had expected to trade space for time, falling back rapidly toward their own borders and prepared defenses, shortening their own supply lines while elongating those of the Allies. The Germans reasoned that their rapid retreat would not only extend the Allied supply lines but also dislocate them and so leave their tactical spearheads vulnerable to a Nazi counterthrust.

The reasoning of the German generals was strategically sound, but they were surprised by the ability of the Allies to sustain their attack and deprive the Germans of the breathing spell they had expected to gain by rapid retreat. An important contributing factor in this Allied success—the ability to sustain the pressure on the Germans—was the availability of combat rations. Compact, portable, instantly usable without elaborate preparation or cooking, these rations were a triumph of *low* technology. They were vital to the strategic success of Allied arms.

Dr I. B. Holley
In Margiotta and Sanders, *Technology, Strategy and National Security*

Combat Logistics—1944

20 August 1944. This morning, at a formation of the 89th Air Service Squadron, we presented the Bronze Star Medal to three enlisted men of the 89th. Colonel West pinned on the decorations, after I had read the citation.

On the night of 8-9 March 1944, these boys had been in Lalaghat, India, with the 1st Air Commandos. Two C-47 airplanes of the 27th Troop Carrier Squadron were reported down and damaged on a temporary strip east of the Irrawaddy River, deep in enemy territory in Burma. The field had been abandoned, as the Japs had a fighter field at Shwebo (only 50 miles away) and had ground troops in the near vicinity.

Knowing that the mission was very dangerous, these boys were a part of a volunteer repair crew who were flown into this abandoned field and successfully repaired both ships and got out before the Japs got there.

We were all delighted to see this recognition of the bravery and accomplishment of service troops, especially as they are our troops. The boys saved two C-47 airplanes at a time when C-47 airplanes were badly needed, and they deserve a lot of credit for their performance.

As an armchair tactician, I think without the C-47 airplanes of the two troop carrier groups in our area during March-June, the Japs would have been highly successful in their sally into India. They would have taken Imphal, Dimapur, the railroad, and river to Ledo, and they would have cut Stilwell's North Burma off from home base. As I look at the Japanese campaign, it was moderately successful as it ended, but had it not been for these C-47s that flew into the Imphal area several divisions from great distances, the Japs would have found the picking easy.

Hero of the Hump—the Curtiss C-46 Commando.

J. P. Bondurant
"Personal Diary" from *The 54th Air Service Group: A Historical Compilation*

Book or no book, the men go out into the combat zone as experts. And as something more, for added to their skill is a definition-resisting but strictly American synthesis of skepticism, inventiveness, and doggedness. If holders of the peacetime faith condemn as heresy the notion that anything other than a rubber tire can be put to an airplane wheel rim, these guys have nonetheless tried—and succeeded in—substituting a coil of Chinese peasant-made rope. They are pragmatists, and because they held their high-school jalopies together with nails and chewing gum, they do the same with airplanes and count it good because it works. If a factory manager would scream at the thriftless idea of ten men spending 3 months rescuing a wrecked plane, a bomber commander whose hitting power is thereby, and only thereby, increased by 10 percent does not quibble about cost accounting. They are resourceful, and they are determined. When a gasoline dump takes fire, the mere expert's way of extinguishing it, if at all, is not to drive into it with a bulldozer-scraper, shoving dirt on the flames. But if a bulldozer-scraper is the only equipment you have on a North African airfield and a sergeant with a lot of guts puts out the fire and saves 5,000 gallons—well, there are other values besides orthodoxy.

Captain Alfred Friendly

The Hump Airlift Operation

"The Japanese may have cut the Burma Road," announced President Franklin D. Roosevelt in February 1942,

> . . . but I want to say to the gallant people of China that no matter what advances the Japanese may make, ways will be found to deliver airplanes and munitions to the armies of China. We remember that the Chinese people were the first to stand up and fight against the aggressors in this war.

This commitment to support the Chinese Government of Chiang Kai-shek fighting more than a million Imperial Japanese troops precipitated the most extensive airlift yet undertaken by the United States. As a result, throughout the remainder of the war, personnel involved in the *Hump* airlift, a 500-mile aerial pipeline over the treacherous Himalayan Mountains, flew approximately 180,000 missions delivering more than 650,000 tons of war material. The airlift contributed directly to the Allied war effort and taught Americans enduring lessons about the capabilities of airlift.

Beginning the Airlift

The story of the *Hump* airlift of World War II began in 1937 when the Japanese first invaded China. Republican China resisted this action and developed a scorched earth strategy of trading territory for time as it pleaded with western Allies for military aid. This aid came in the form of lend-lease supplies and equipment and the American Volunteer Group (AVG), a rowdy gang of misfit fliers under the command of Claire L. Chennault who made a name for themselves as the *Flying Tigers*. With the Japanese attack on Pearl Harbor on 7 December 1941, the United States was drawn into the fighting and forced to reassess its priorities for aid to its allies. While trying to continue support of China, government leaders believed the first priority must be given to assisting Great Britain to defeat Germany, and the Asian theater received less attention.

Because of these priorities, the United States was unable to provide as much assistance as its leaders wanted and was forced to send only sufficient supplies to allow the Chinese and American troops in Asia to continue a holding action against the Axis troops. Japan, on the other hand, was intent on defeating China rapidly to end a significant drainage on its resources. To do this, the Japanese high command moved to secure Burma, the principal country through which supplies entered China. In late December 1941, they invaded this British colony, throwing 100,000 men and 700 aircraft into the campaign. Although the British fought bravely, they were unable to defeat this massive force and capitulated in April 1942. China was virtually cut off from the outside world, or so it seemed.

Even before Burma's loss, General Henry H. Arnold, Commander of the Army Air Forces, had recommended to the President that an air route from India to China be developed because of the difficulty of sustaining group supply lines. He worked to ensure this capability and encouraged contracting the China National Aviation Corporation (CNAC), a jointly owned company of Pan American World Airways and the Chinese Government, which had pioneered an air route between India and China over the Himalayas in the 1930s, to supply these forces. This airline, however, had insufficient resources to support the Allied effort; consequently, the AAF's Tenth Air Force, headquartered in India, was given responsibility for the operation. On 8 April 1942, Colonel William D. Old made the first military flight over the *Hump*. Thereafter, the Army Air Forces deployed additional assets to India, and the airlift began to grow. Starting as a mere trickle, in April and May 1942, the first 2 months of the operation, the Americans delivered 196 tons, and CNAC delivered 112. Gradually, the airlift increased until by November 1942 the two organizations were delivering more than 1,000 tons per month. This was insufficient to ensure the continued resistance of China, however, and action had to be taken to increase the efficiency of the airlift. Accordingly, on 21 October 1942, the Air Transport Command was directed to accept responsibility for the *Hump* operation. Implicit in this directive was the understanding that the Tenth Air Force was not the proper organization to manage the aerial transport mission. Effective 1 December 1942, the units involved in the airlift were transferred to the Air Transport Command and redesignated the India-China Wing, under the command of Colonel Edward H. Alexander, who had previously been executive officer of the Ferrying Command and understood well the nuances of airlift operations.

Weather conditions alone were enough to make the *Hump* route the most treacherous AAF operation of the war. It was not uncommon for sudden winds reaching almost 250 miles per hour to create turbulence so great that a heavy cargo airlift might flip, roll, or plummet 3,000 feet a minute as if it were a dinghy in a typhoon. Fully 6 months out of the year, *Hump* aircrews contended with monsoons that drenched the countryside, created turbulence, and made operations practically impossible. Colonel Alexander wrote to a superior about the problem with weather in 1943:

> The weather here has been awful. The icing starts at 12,000 feet. Today a C-87 went to 29,000 feet on instruments, was unable to climb higher, and could not get on top. It has rained 7-1/2 inches in the last 5 days. All aircraft are grounded.

So extreme was the weather that at first the Japanese Air Force did not consider the airlift a threat to the China offensive and ignored the flights. They soon changed their minds. Later, as the airlift became more successful, Japanese patrols attacked the transports. On one occasion, a C-47 flying the *Hump* actually scored a victory over an attacking Japanese Zero. When two enemy fighters attacked, the pilot dove between mountain peaks to allude them.

The aircraft lost one Zero, but the second stayed with it. "That character must have been trying to ram us because he never swerved," the pilot recalled. He just missed the C-47,

but afterward the Zero "kept right on going, and we watched him explode as he hit the side of the mountain." Later in the war, the ATC *Hump* operation used two C-47s for search-and-rescue operations. Each of those aircraft had .30-caliber Bren machineguns. Occasionally, these aircraft would be attacked by Japanese fighters looking for easy scores from the normally unarmed transports and surprise the enemy with their armament.

Colonel Alexander, a believer in the capabilities of air transport to supply fighting forces, was tireless in his efforts to increase tonnage of the airlift. He demanded and received added resources. He was only partially successful. In February 1943, for instance, the airlift transported 2,855 tons to China before the monsoon season began and operations had to taper off. Delighted with these efforts but convinced he could not increase tonnage without additional assets, Alexander demanded more personnel and equipment. Most critical were qualified pilots. "Get me some aircraft crews if it is humanly possible," he begged. "I hate to see good, serviceable aircraft sitting on the ground with no one to fly them. An airplane doesn't need to sleep."

Expanding the Airlift

If there was a pivotal event in the history of the *Hump* airlift, it was the Trident Conference held in Washington DC in May 1943. Its primary purpose was the determination of the time and place for the invasion of Europe, but Roosevelt also used it to formulate a unified policy for Asia. A month earlier, General Chennault had visited Washington to convince the President and the Joint Chiefs of Staff that his plan for an aggressive air offensive against the Japanese in China was the key to victory in Asia. The success of such a campaign, however, rested on the ability of the Air Transport Command to increase the tonnage it carried over the *Hump*. President Roosevelt had accepted this plan's feasibility and engineered its adoption at the Trident Conference. As a result, the President directed that the Air Transport Command push its cargo supply activities to 5,000 tons by July, 7,500 by August, and 10,000 tons per month by September 1943. Known officially as *Project 7,* Colonel Alexander called it less formally the *July-September Objective* and later *the 10,000-ton objective*. Overworked airmen assigned to the *Hump* operation had less kindly names for it.

To accommodate this new requirement, the India-China Wing received ever-increasing resources. The President also directed that materiel, equipment, and personnel be shifted from roadbuilding to airfield construction. Consequently, the India-China Wing oversaw the construction of several new airdromes on both sides of the Himalayas. By 1 July 1943, General George C. Marshall, Army Chief of Staff, ordered fields in India at Chabua, Mohanbari, Sookerating, and Jorhat to be completed, each with a minimum of 20 hardstandings. Other airfield construction projects followed. Construction was so extensive that by the end of the war ATC pilots were using 13 bases in India and 6 in China, a marked expansion from less than 3 years earlier when the *Hump* pilots shuttled between a single airdrome on each side.

In the back-country regions of Asia, this accomplishment was nothing less than phenomenal. Since heavy equipment was at a premium, the commander of the Services of Supply in the theater, Major General Raymond A. Wheeler, used civilian laborers for the difficult process. These workers chipped by hand large rocks into gravel, carried them to the runway site in baskets or by oxcart, and often graded the airstrip manually using hand-operated rollers. The Services of Supply units employed thousands in this work; at one airfield on the Yangtze River, China, more than 100,000 people labored to construct a single 6,000-foot long airstrip. The results, while not spectacular, pleased aircrews who found these bumpy and rocky strips quite usable.

At the same time, General Henry H. Arnold, Commander of the Army Air Forces, ordered that still more men and aircraft be allocated to the *Hump* operation. As a result, during the remainder of 1943, the India-China Wing received additional aircraft. By the end of the year, 93 C-46s, 25 C-47s, and 24 C-87s were in regular service over the *Hump*.

Slowly, with the India-China Wing's more effective organization and greater Air Staff support, the *Hump* airlift totals began to rise during the latter part of 1943. The airlifters did not meet the 10,000-ton objective on schedule, but in December 1943, they surpassed it, only 4 months behind the proposed date. Recognition for this achievement came the next month when President Roosevelt awarded the India-China Wing a special citation, the first time such a military organization had been recognized in this manner. General Chennault, commenting on this accomplishment, addressed the India-China Wing commander, "I am particularly anxious that your pilots and crews know that only through their efforts can we accomplish these important missions."

These accomplishments came despite incredibly difficult living and working conditions. The average soldier complained about his assignment from the time he arrived until he departed, and India-China Wing commanders and nonmilitary observers recognized the heroic efforts of those involved in the *Hump* airlift. The impressions of Lloyd S. Gray, an enlistee assigned to an airdrome at Dum-Dooma, India, were probably common. Gray commented that India's heat was virtually unbearable, observing, "Kipling's line 'Mad dogs and Englishmen go out in the midday sun' really means something to me now." To beat the interminable heat, Gray once stood in line for an hour to get a spoonful of ice cream. "When I get home I am going to live on cold drinks and ice cream," he said "I never knew I could miss anything so much." The accommodations also left a great deal to be desired. Gray thought that India had more insects per capita than "any other place in the galaxy. Moreover they seemed to love Americans for they infested practically every bunk in the theater. Eric Sevaried, who covered the China-Burma-India Theater for the CBS Radio Network, commented on the difficult conditions during a visit to the *Hump* base at Chabua, India. "There were at this time absolutely no amenities of life—no lounging places, no Red Cross girls, nothing cool and refreshing to eat and drink, no nearby rest resort to visit on leave. It was a dreary and dismal place."

In spite of these factors, the men involved in the *Hump* airlift showed surprising courage and resourcefulness. Some aircraft pilots adopted the characterization of one unimpressed observer who wrote that they were "living like dogs and flying like fiends." Many developed a unique and slightly morbid sense of humor and spirit about their work. Some *Hump* pilots laughed at the dangers of the operation, joking about the aluminum-plated trail beneath them where comrades had crashed. Complaining about the lack of respect they received from fighter pilots, one *Hump* veteran said, "What the hell? A pursuit plane has six .50-caliber guns in front of him and 400 miles per gallon in his engine. We fly the same country with a pistol and a Tommy gun."

Along with the hard-won increases, unfortunately, also came heavy losses in men and equipment. Between June and December 1943, there were 153 major aircraft accidents on the *Hump* route, and 168 crew fatalities resulted. Brigadier General Cyrus R. Smith, ATC Deputy Chief of Staff, commented:

> We are paying for it (increased tonnage over the *Hump*) in men and planes. The kids here are flying over their head—at night and in the daytime, and they bust up for reasons that sometimes seem silly. They are not silly, however, for we are asking boys to do what would be most difficult for men to accomplish; with the experience level, here we are going to pay dearly for the tonnage moved across the *Hump* . . . . With the men available, there is nothing else to do.

To ensure greater pilot proficiency, the Air Transport Command immediately instituted more stringent flight checks.

This measure had the effect of increasing safety awareness. Captain Bliss K. Thorne commented on some of the safety precautions of the aircraft commander when he recalled his first flight over the *Hump* in 1943. As the aircraft reached cruising altitude, for instance, the pilot gave Thorne the controls and went to the cargo compartment to check the 55-gallon fuel drums they were carrying. When he found three drums leaking noticeably, a common problem in the unpressurized aircraft at the high altitude needed to fly over the *Hump*, he jockeyed them back to the cargo door and pushed them out into the jungle below. Sometimes pilots refused to take off until certain maintenance or loading procedures that had been omitted were corrected. In spite of this awareness, sometimes grisly accidents took place. Lloyd Gray, for instance, reported on 11 October 1943 that a C-47 from his base in Assam blew up just after takeoff, killing the entire crew. Those at the runway, according to Gray, "Said she was loaded with gas and ammunition and the pilot almost refused to take off because he did not think the loading was properly done. Those who saw it said there was just a big puff of smoke and she was gone." Later, Gray added that because of the accident, "Morale is at an all time low here. The new men especially are practically refusing to fly." This incident did not stop the airlift, however. Private Gray probably summarized most of his comrades' feelings when he wrote, "I don't want to go, but duty is duty. If I had wanted to win the war from behind a desk, I would have stayed in the States."

Whenever there were accidents, the wing sought to ensure the recovery of the downed aircrews with an aggressive search-and-rescue program. An example of what was known in World War II as the finest search-and-rescue program yet devised came on 2 August 1943 when a C-46 carrying 17 passengers from Chabua, India, to Kunming, China, experienced engine failure. All but one of the crew and passengers—including William T. Station of the US Board of Economic Affairs; John Davis, a Department of State official serving on General Stilwell's staff; and CBS broadcaster Eric Sevaried—bailed out and landed safely. The only fatality was the copilot whose parachute apparently caught on the tail section. Search-and-rescue aircraft immediately went into action and spotted the survivors in the jungle. Since the harsh terrain prevented the immediate rescue of the group, the aircraft dropped emergency supplies. Because several of the survivors needed medical attention, Colonel Donald Flickinger, a physician, and two enlisted personnel parachuted to assist them. Thereafter, a British patrol was sent from a forward Indian base into the jungles to link up with survivors and escort them to safety. All told, it took 2 weeks for the party to return to civilization, but it suffered no other casualties in the episode.

The Age of Big Business

Tonnage carried over the *Hump* continued to rise throughout the first months of 1944. In June 1944, the India-China Wing delivered more than 15,000; in August, it transported more than 20,000, and by November, the tonnage figures had risen to 34,914 tons. To support this rate, transport aircraft took off over the *Hump* at an average of one every 3 minutes. Even as the tonnage of *Hump* resupply rose, on 3 September 1944, Brigadier General William H. Tunner became commander of the unit managing the operations. General Tunner already had gained recognition for making ATC's ferrying division into the largest and most efficient activity in the command. His mission as commander of the redesignated India-China Division was twofold: increase tonnage while decreasing accidents.

General Tunner was a superb administrator whose talents were well suited to these tasks, and he soon initiated several improvements in the system. First, Tunner gained increases in the number of personnel and aircraft assigned to his command, from 249 aircraft and 17,032 men in December 1944 to 332 aircraft and 22,359 men at the end of the war. Still, these resources were insufficient for Tunner's vision of the *Hump* airlift. He sought to demonstrate the need for more personnel by using civilians and, at least in India, elephants to help load aircraft. "I did hire elephants, which loaded gasoline drums from trucks into C-46 airplanes," remembered Tunner. "I later had the pictures of Indians scrambling all over the airplanes, washing them down and the elephants loading gasoline drums, and sent them back to my bosses hoping that they would see that I was in great need of personnel." Tunner added, however, that this ploy backfired; his superior responded with a note, "Since you've done so well in hiring indigenous personnel and elephants, I shall have to take some more men away from you to send to Southeast Asia."

Tunner developed, with his staff, a comprehensive safety program. They prepared a statistical tracking program to determine the causes of aircraft failures, the airfields where the most accidents took place, the type of weather involved, the model of aircraft most prone to accident, maintenance deficiencies, and a host of other questions. Tunner remarked, "To answer these and many other questions, Captain Stiles (the division's flight safety officer) set up statistical systems, which were certainly the best in effect in any theater at the time and are still good today." This information—coupled with more rigorous flight checks, aircrew physicals, and an efficient safety awareness program—proved most useful in combating accidents.

General Tunner also took a major step toward greater aircraft reliability while decreasing maintenance time by introducing production-line maintenance (PLM). This procedure required an aircraft to be towed through a succession of seven maintenance stations where specially trained crews performed specific maintenance operations. To make this feasible, each Assam base specialized in repairing one type of aircraft; consequently, maintenance operations could be more efficient and effective. At Tezgaon Field, for example, crews specialized in C-54 aircraft and could move each through the PLM line in 22 hours. Although at first Tunner encountered some opposition to this maintenance concept, he persisted and within a few months had each base successfully involved in the project. Because of production-line maintenance, the number of operational aircraft rose from 75 percent in January 1945 to 85 percent before the end of the war. The daily utilization rate also rose sharply during the same period, increasing from 7.51 hours per aircraft per day in April to 11.65 hours in July 1945, the last full month of operations. The time required for the 100-hour aircraft inspection was also reduced 25 percent during these months.

Each of these actions accomplished Tunner's goals of increasing tonnage while decreasing accidents. The *Hump* operation delivered 44,098 tons in January 1945; by July, this had been increased to 71,042 tons. All the while, the accident rate dropped from 23 accidents and 36 fatalities in January to only 8 accidents and 11 fatalities in the last full month of the war. With the end of hostilities in August 1944, the *Hump* airlift declined swiftly, dropping from 53,315 tons in August to 1,429 tons in November, the month it ended.

Conclusion

Today, 40 years later, the *Hump* airlift of World War II invites serious reconsideration. It could be divided into three major episodes, each having its own special place in the history of the war and the evolution of the Air Force. First, from its inception in April 1942 to the summer of 1943, the airlift was little more than a primitive barnstorming operation; resourceful personnel involved worked to gain additional men and aircraft, supplies, and equipment to support the Allied forces in China. During this period, the airlift was at best a second-class operation that had low priority among the overall wartime goals of the Army Air Forces. Second, between the summers of 1943 and 1944, the India-China Wing commanders presided over an expansion of the airlift to support increased operations in China and Burma. Third, after mid-1944, the airlift entered its most mature phase. Under General Tunner, who marshaled greater resources and enjoyed higher priority for assistance than any previous commander, the *Hump* airlift resembled a big business involving the largest and most complex mass transport system in history.

More important, the *Hump* airlift made possible the continued resistance in China. Between 1942 and 1945, 81 percent of all supplies entering China came over the *Hump*. Without these supplies, the defense of China would not have been possible. As it was, the Allies in China were able to avoid being crushed by Japanese military might. The Japanese Imperial Army was forced to maintain 1.2 million troops and uncounted numbers of valuable resources on the Chinese mainland. Had it achieved a quick victory there, Japan could have left a small occupation force in China and moved the remainder of its force to oppose the Americans in the Pacific, perhaps making the island-hopping campaigns more costly than they were.

Whatever other results of the *Hump* airlift, the operation had critical importance for the development of airlift doctrine. The researchers preparing the Strategic Bombing Survey following the war recognized this significance:

> The major significance, for the future, of all air operations in CBI (China-Burma-India) was the development of air transport operations. During the first year of the war, the magnitude to which air transport operations could be developed was not appreciated. However, the terrain of Burma and China and the absence of land lines of communication forced all agencies in the theater to turn to the airplane—initially as an afterthought and an emergency last-chance measure. The inherent flexibility of airpower permitted it, without adequate preplanning, to meet the exigencies of the various expanded air transport operations expanded beyond the wildest prediction of 1942—expanded because it was the one agency that could succeed.

Large-scale air supply remained a critical part of American military planning until the present. Its use in the Berlin airlift of 1948-1949; Korean War, 1950-1953; Vietnam War, 1963-1973; and Israeli airlift of 1973 have amply demonstrated its effectiveness. While procedures have been refined and equipment made more efficient, the basic air supply techniques used in the *Hump* remain in operation today.

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Notes

Much of the information in this article is contained in Wesley Frank Craven and James L. Cate, eds., *The Army Air Forces in World War II*, 7 vols. (Chicago, 1948-1958). This work is complemented by Charles F. Romanus and Riley Sunderland, *China-Burma-India Theater: Stilwell's Mission to China* (Washington DC, 1953); H. H. Arnold, *Global Mission* (New York, 1949); Reginald M. Cleveland, *Air Transport at War* (New York, 1946). Oliver LaFarge, The *Eagle in the Egg* (Boston, 1949); William H. Tunner, *Over the Hump* (New York, 1964); and Eric Sevaried, *Not So Wild a Dream* (New York, 1946). Bliss K. Thorne, *The Hump: The Great Military Airlift of World War II* (Philadelphia, 1965), has interesting personal insights from the perspective of a pilot involved in the operation. The best synthesis of the airlift remains William J. Kownig's popularly written, *Over the Hump: Airlift to China* (New York, 1972).

Amphibious Warfare: Logistics Over the Shore

The tools of amphibious warfare had no place in the victory program of 1941 or in any other prewar plan for industrial mobilization. Production officials, as well as military leaders, had failed to foresee the need for a massive arsenal of amphibious equipment. The impetus for production of assault shipping, consequently, grew out of specific needs to fulfill specific operational requirements that the planners began to foresee only dimly in 1942.

Procurement of amphibious equipment of all types, except the DUKW and other wheeled amphibians had been made a Navy responsibility by the end of 1942. By agreements with the Army in early 1943, the Navy also took over responsibility for training all amphibious crews and manning all landing ships and craft except those entrusted to the Army engineer special brigades in the Southwest Pacific.

Logistics procedures were developed to mount and support the scores of amphibious operations in the Pacific and—based upon the experience of the great landings in North Africa, Sicily, Italy, Normandy, and Southern France—constituted one of the major American contributions to the art of warfare.

The most significant innovation determining the special characteristics of these operations was the design and construction of special vessels for the purpose—combat loaders and landing craft of various types. Combat loaders were the three main types—the attack personnel transport (APA); the converted destroyer transport (APD) for carrying personnel and equipment; and the attack cargo transport (AKA), mainly for cargo. Although designs for special landing craft were being prepared in the United States, it was the Japanese who introduced these vessels into warfare in their invasions of the Philippines and Malaya, while the British used similar craft in their North African operations. The United States soon developed new types and produced them in great quantities. They quickly became so important that they were critical items of equipment throughout the war, and as already noted, strategic decisions and the timing of major operations frequently hinged upon their availability.

Common characteristics of these vessels were a bow which could be opened to permit lowering a ramp or a bow which itself could be lowered as a ramp so that troops, tanks, trucks, and other vehicles could move out directly to the beaches under their own power, shallow draft, and controlled water ballast so that the vessel could be beached at low tide and floated off at high tide. The vessels fell into two general categories: *landing ships*, oceangoing ships, especially useful for shore-to-shore operations; and *landing craft*, intended to be carried on board combat loaders of other ships or to be used across relatively narrow straits. Of the dozen or so types, the most important of ships probably was the *LST*, which might carry, for example, 20 medium tanks on its tank deck; the *LSM* (landing ship, medium); and the *LSD* (landing ship, dock), a floating drydock which carried landing craft and amphibious vehicles that could be launched from ships and proceed across water and up on the beaches under their own power (such as the Alligator, an amphibious tractor used to carry troops and equipment ashore); the *amphibious tank*, for combat support; and the previously noted amphibious 2-1/2-ton truck, the DUKW.

The shipping required for an amphibious assault force varied according to the length of the voyage, the mission, special equipment, and the proportion of landing craft and amphibious vehicles carried. For a short voyage, a force equivalent to a reinforced infantry division of some 22,300 men, with 3,600 vehicles, in a fairly typical case might take 9 APAs, 6 AKSs, 36 LSTs, 12 LSMs, and 2 LSDs. In the choice of landing sites the main considerations dealt with the advantages and disadvantages of the beaches; that is, their exits and approaches in permitting logistical followup as well as the initial landings. It was desirable to avoid the reefs and shoals characteristic of Pacific atolls and islands. If they could not be cleared by 4 feet at low tide, then it was necessary to go in at higher tide, even though that complicated beaching and floating of the craft. Beaches with too gentle a slope caused landing craft to ground at long distances from the shore line, while a too steep gradient made discharge of vessels difficult. In a surf running higher than 4 or 5 feet, amphibious vehicles operated at great hazard. The beaches themselves had to be firm enough for traction.

For amphibious operations over any extended distance in the Southwest Pacific, troops generally were transported in APDs and landed by landing craft carried on board. If the landing had to be made over coral reefs blocking the beaches, amphibious tractors and DUKWs had to be used for the initial assault. As soon as a way was cleared, LCTs carrying tanks and shore party engineering equipment were launched from the flooded well of an LSD, and the successive waves of infantry arrived in LCIs hopefully spaced and timed to avoid congestion. About an hour after the assault, several LSTs would arrive with troops, vehicles, and supplies to be unloaded before nightfall. For the followup after a landing, any and all types of landing vessels might be used. Echelons usually would go in at 3- to 5-day intervals until Army Services of Supply could take over responsibility with its own merchant shipping.

For shore-to-shore operations, MacArthur relied on Army engineer special brigades to man fleets of landing craft. This gave them special significance, for only in the Southwest Pacific did the Navy not man all the boats in such operations. After specialized training at the engineer Amphibian Brigade Command on Cape Cod, the 2d Engineer Amphibian Brigade (later redesignated as the 2d Engineer Special Brigade) went to the Southwest Pacific in November 1942; a second brigade arrived in October 1943; and a third in May 1944. Like the brigades serving in the Mediterranean and in the Normandy landings, these brigades also had responsibility for organizing shore party teams to unload the assault ships and set up transportation and lighterage for supply buildup. Beach parties, as distinct from shore parties, were Navy units charged with coordinating the arrival of boats and ships on the beaches, seeing to the evacuation of casualties in waiting vessels, and getting vessels back off the beaches once they had been unloaded. In all these duties, they had to work very closely with the engineer shore parties. Ultimately, the VII Amphibious Force, controlling the Navy beaching craft of General Douglas MacArthur's command organized and trained eight beach parties, each composed of 3 naval officers and 18 men (3:549-550).

Women's Uniforms—A Supply Nightmare

Despite a somewhat masculine appearance, the basic design of the Women's Army Auxiliary Corps (WAAC) uniform was not all that bad considering how little precedent there was to go on. The end product, however, could not have been worse from any standpoint—cut, fit, color, tailoring, material, quality.

To begin with, the supply depot had failed to make graded designers' models in the various women's sizes, so the manufacturers had to develop their own. The contracts were let to manufacturers of men's wear because the women's garment manufacturers could not make them at the price the Army would pay. As might be expected, the end product looked and fit as though it had been intended for men rather than for women. The jackets were heavily padded in the shoulders and flat chested, and the skirts were too narrow for women's hips. Moreover, the material used was generally unsatisfactory for women's clothes, and the colors of the skirts and jackets rarely matched. The general cut of the uniform—plus the low-heeled, laced oxfords, men's shirts, and neckties—created a generally unfeminine appearance that did not enhance the WAAC's public image.

The supply system was a bureaucratic nightmare: the Army was unable to issue one complete set of authorized uniform items to its first group of female recruits. During the first winter, half the women in some training centers graduated without uniforms. One center opened in Massachusetts in March 1943 with no uniforms at all. Thousands of women had to endure training, often in the snow, wearing the same single civilian outfit they were allowed to bring from home. The Army had simply failed to let the contracts in time or in sufficient quantities to meet the recruit accession schedules. Moreover, the supply system got fouled up by a requirement to disperse the stocks on hand to five different training centers to support the unprogrammed expansion of WAAC recruiting. In one instance, a supply depot shipped clothing items needed at one training center to another center and vice versa, and the depot commander refused to exchange them because it would confuse his records. Even when supplies arrived, the depots soon ran out of small sizes. Said one dismayed trainee, "It looks like those clothes were intended for a race of giants." An enormous amount of time and effort were expended cutting size 18L to fit size 10S.

By the time the supply began to catch up with the demand in mid-1943, the bottom had fallen out of the recruiting program, and the Army was stuck with an enormous surplus of uniforms. By then, the gross deficiencies in quality and fit were evident, but because of the surplus of stocks, new improved uniforms could not be procured. The women were stuck with them. Not until the Army realized the negative effect the sorry state of uniforms was having on morale and recruiting was the decisions made to get rid of the surplus and introduce a decent uniform.

The Navy avoided the Army's problems by going to a well-known women's fashion designer, Mainbocher of New York, for the original design and then contracting with the women's fashion industry to make the uniforms.

Another major controversy had to do with hose. Since men did not have to wear them, there was no precedent to fall back upon, and civilian custom required that women wear hose. Decisions on the matter were dictated to a large extent by wartime shortages. Japanese silk was no longer available, and the new nylon had immediately disappeared from lingerie and hosiery shelves to reappear as parachutes. The only material left for stockings was cotton—either heavy or the finer lisle—and rayon. The Army had settled for the cotton in tan shades, which soon turned a dingy greenish yellow; but the Navy would not hear of cotton.

McAfee termed the ensuing conflict, which was resolved by a high-level decision, as the "battle of the black stockings." The Chief of Naval Operations, after visiting Canada and being impressed with the Women's Royal Naval Service members in black stockings, insisted that the Women Accepted for Volunteer Emergency Service (WAVES) should wear them, even though they strongly objected. American women did not wear black hose except in the evening hours, and the only ones available were sheer rayon—very fragile and inappropriate for daytime wear. But the Chief of Naval Operations would not be dissuaded; not even his wife or his daughter could convince him. Only when he was told by a man at a dinner party that the dye used for black stockings was also needed in the manufacture of gunpowder and that it was in short supply, did he back down. Because he did not want to jeopardize the war effort, Navy women could wear the tan rayon hose they preferred.

Major General Jeanne Holm
Women in the Military

You will not find it difficult to prove that battles, campaigns, and even wars have been won or lost primarily because of logistics.

Dwight D. Eisenhower

World War II Spurred a Resurgence of Logistical Thought

Major General Graham Rider

The task of moving and supplying armies assumed by our nation during World War II was greater than ever before experienced in military history. Troops and supplies were moved to the South, Central, and North Pacific Ocean areas; to China, Burma and India; to Russia through the Persian Gulf; the Barents Sea; the Mediterranean; and of course, to Europe. The Army judged its prewar organization inadequate for this huge task. Accordingly, it reorganized early in the war to form the Army Service Forces along with the Army Ground Forces and the Army Air Forces.

A Broad Definition

The Service Forces seemed equal to the task of moving and supplying armies all around the world, but in the opinion of the headquarters staff, the words *supply* and *service* were not. Logistics seemed more appropriate, and by the time the organization disbanded, following the war, its use had become official. The ASF's final report was titled *Logistics in World War II,* and its introduction explained the use of the word in this manner:

> The word *logistics* has been given many different shades of meaning. A common definition is: "That branch of the military art which embraces the details of the transport, quartering and supply of troops in military operations." As the word is used in the following pages, its meaning is even broader. It embraces all military activities not included in the terms *strategy* and *tactics*. In this sense, logistics includes *procurement, storage, and distribution of equipment and supplies; transportation of troops and cargo by land, sea, and air; construction and maintenance of facilities; communication by wire, radio, and the mails; care of the sick and wounded; and the induction, classification, assignment, welfare and separation of personnel.*

Now this was a significant development for logistics. It occurred in one of the largest organizations ever assembled by man, and it contributed to victory in one of the largest wars ever engaged in by man. Since one usually does not argue with success, logistics was accepted in the postwar years as much more than moving and supplying armies—the concept was expanded to include construction, communication, medicine, and personnel.

Narrowing the Scope

In 1948, a very slightly reworded version of the italicized part of the preceding quote appeared as the official JCS definition of logistics. However, it was not universally accepted by the military establishment. Presumably, the doctors, communicators, personnel managers, and others did not see themselves in quite the same way that the Army Service Forces did. Furthermore, one really cannot see any difference between that definition and one describing the entire field of military administration. In any event, attempts were made in the next few years to reword the definition so it would conform to actual military applications. The result was achieved in 1953 and has remained virtually unchanged since.

> **Logistics.** The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations that deal with:
>
> a. Design and development, acquisition, storage, movement, distribution maintenance, evacuation, and disposition of materiel.
> b. Movement, evacuation, and hospitalization of personnel.
> c. Acquisition or construction, maintenance, operation, and disposition of facilities.
> d. Acquisition or furnishing of services.

A Muffled Debate

Interestingly enough, those who have become involved with logistics, particularly those with an inclination toward military scholarship, have given less than enthusiastic support to the official definition. In whole or in part, they have tended to ignore it. Their efforts have taken the form of intensive scholarly inquiry and practical organization experimenting, most of which began with the book *US Naval Logistics in World War II,* written by Duncan Ballantine and published in 1947 at the same time as was the report of the Army Service Forces mentioned earlier.

Ballantine was a historian and was encouraged and supported by the Navy to record the history and lessons of naval logistics during the war. He saw logistics as a process in which "the raw warmaking capacity of the nation is translated into instruments of force ready to be employed in pursuit of strategical or tactical objectives. As such, it is both an economic and military undertaking."

Navy Developments

In 1949, the Navy established The George Washington University Logistics Research Project. As mentioned previously, the subject of logistics had been taught at the Naval War College as far back as 1888. Benefiting greatly from the results of the ongoing Logistics Research Project, the War College was able to place new emphasis on the subject in its curriculum. Rear Admiral Henry E. Eccles participated in the research project and in the Naval War College educational program. He has been a key figure in the latter and has written three books on logistics as well as numerous articles. Using his own studies and research to build upon Ballantine's foundation, Eccles offered a perceptive definition of logistics in 1959:

Logistics is the provision of the physical means by which power is exercised by organized forces. In military terms, it is the creation and sustained support of combat forces and weapons. Its objective is maximum sustained combat effectiveness.

Army Developments

The Army also encouraged historians to work under its auspices in World War II and allowed them unlimited access to its files both during and after the war. Many Army studies have been published, but the most notable were two volumes written by Leighton and Coakley and two by Ruppenthal that dealt with global logistics and European logistics, respectively. Their studies imply the same concept of logistics as was proposed by Ballantine. Leighton and Coakley observed in 1955 that, in spite of the official definition of logistics then published by the Joint Chiefs of Staff, there existed differing military interpretations of logistics. They were found in speeches and writings by members of the Services and especially in organizational applications that varied widely from the official definition. They concluded that there was a:

> . . . widespread uncertainty in the military profession itself as to precisely where logistics stops and something else begins. Evidently the term is still in the process of rapid and healthy growth. Until it matures and settles down, we must accept it, perforce, in whatever guise it appears—that is to say, with the specific shape, content, and emphasis it derives from its concrete environment.

In the years since World War II, the Army created the Logistics Management Center at Fort Lee, Virginia, with responsibilities ranging from academic to practical organizational applications of logistics. Army schools, particularly the Command and General Staff School at Fort Leavenworth, emphasize logistics in their curricula. The Army has also been a major contributor to the evolution of the modern concept of logistics.

Air Force Developments

The Air Force also sponsored logistics research in the postwar era. The RAND Corporation, established on an Air Force contract in 1948, organized a logistics research department in 1954. RAND research has helped the Air Force in its efforts to apply the concept of logistics in everyday operations.

On the academic level, the Air Force organized an advanced logistics course in October 1955 at Wright-Patterson AFB, Ohio, in a residence program offered by the Air Force Institute of Technology (AFIT). In cooperation with Ohio State University, this 6-month course was gradually improved and expanded into a 1-year curriculum that leads to an AFIT Master of Science in Logistics Management. The degree has been fully accredited by the North Central Association of Colleges and Secondary Schools since 1963, and some 500 graduates now hold the degree. Thus, the newest of our services had made its contribution to the store of logistics knowledge.

"Evolution of the Concept of Logistics," *Naval War College Review*, December 1970

In a tale of war, the reader's mind is filled with the fighting. The battle—with its vivid scenes, its moving incidents, its plain and tremendous results—excites imagination and commands attention. The eye is fixed on the fighting brigades as they move amid the smoke, on the swarming figures of the enemy, on the general, serene and determined, mounted in the middle of his staff. The long trailing line of communications is unnoticed. The fierce glory that plays on red, triumphant bayonets dazzles the observer, nor does he care to look behind to where, along a thousand miles of rail, road, and river, the convoys are crawling to the front in uninterrupted succession. Victory is the beautiful, bright coloured flower. Transport is the stem without which it could never have blossomed.

Winston Churchill

Will it Work in War?

Despite all of today's verbiage and verbosity on preparing and planning for war, we still pay only lipservice to the concepts. Would today's logistics systems work in war? It would, I suggest, be foolhardy to answer that question in the affirmative. But that is what it is all about; that is why we are in this business.

Please allow a long-in-the-tooth logistician to reminise for a few moments and draw on his World War II and pre-World War II experiences and memories in order to make some comparisons. Admittedly, these experiences were not with the US military; they were with the Royal Air Force. However, Logistics Warrior seems to be seeking lessons learned from history, and it may not be inappropriate to take a look at how the Royal Air Force met great logistics challenges almost 45 years ago.

As you may recall, the political climate in Great Britain in the 1930s was not especially conducive or encouraging for war planning. Prime Minister Chamberlain had returned from Munich, waving his ubiquitous umbrella and declaring that there would be "peace in our time." Fortunately, the top echelon of command in the Royal Air Force did not accept this reading of the international situation, and every plan and every directive was directed to the possibility, indeed the expectancy, of war. I first put on the blue uniform at this time, and from then until 3 September 1939, when war was declared on Germany, it was drilled into me, almost on a daily basis, that "a day of peace is a day of training for war."

I was constantly reminded that this was the only reason for the existence of the Royal Air Force and the only reason that I was in it. Have we, perhaps, forgotten this premise today? Should we remind ourselves—on a daily basis, as I was jolted in the late 1930s—why we are working for the Department of Defense? In the daily shuffling of papers, should we not, perhaps, remind ourselves why the Department of Defense exists? It exists for one reason and one reason only—to provide this country with a military force so strong that it will deter aggression, with a secondary objective (if the first fails), to fight a war and win. Are we achieving the prime objective? Could we achieve the secondary? If not, what can and must be done about it?

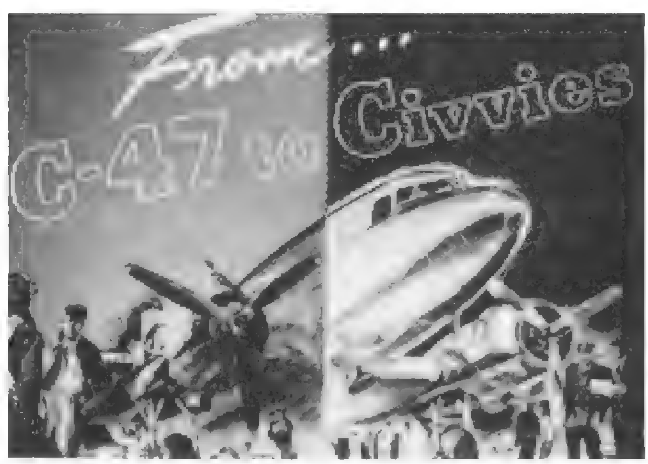
Those are, of course, rhetorical questions, nevertheless, questions we should be asking ourselves. I suggest that we can look at history and get some guidance on what we should be doing.

Returning to my reminiscing of those prewar days of the late 1930s, I recall that the impact of the *plan-for-war* philosophy was manifest in the direction that every staff officer received. Clear and precise directives were given that *no* procedure, *no* system, *no* regulation, *no* form would be designed or written that did not meet and completely satisfy the criterion, "Will it work in war?" This one simple criterion dictated every regulation, procedure, and instruction that was issued; it governed every form and every element of the logistics system. The proof of validity of this philosophy became evident in September 1939 when the transition of the Royal Air Force from a peacetime force to a war-ready force went smoothly and orderly. Systems, procedures, and forms did not need to be changed. Longer hours, of course, had to be worked, and activities had to be accelerated. *Routine* gave way to *expedited*, but still within the priority system established in prewar conditions. This flexibility was built into the system. I am concerned, today, when I see personnel working long hours, trying to meet impractical deadlines and generally slogging away on special projects.

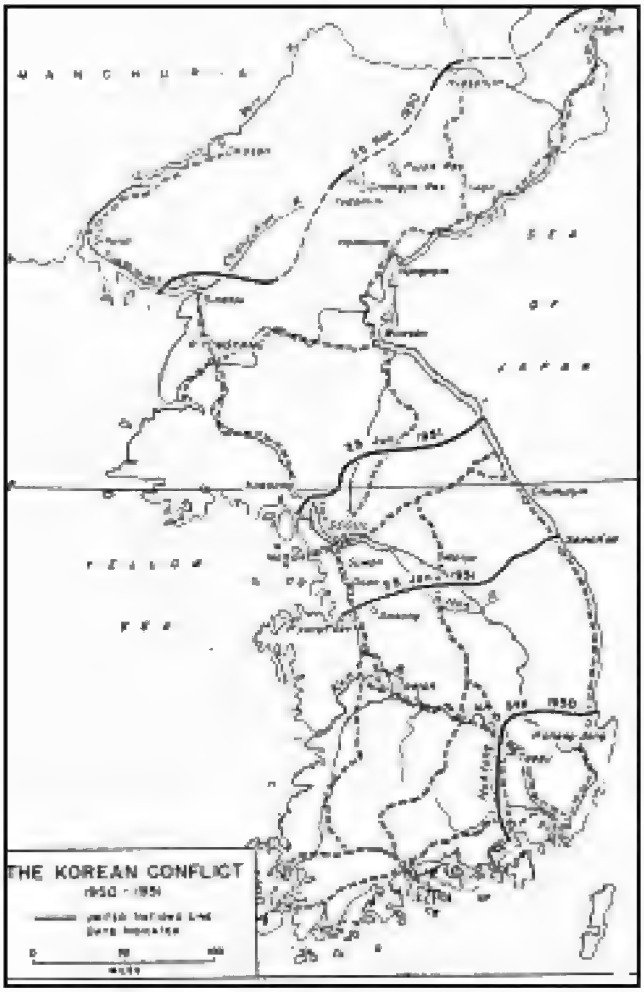
I also witness many aspects of the logistics systems being subjected to constant expedited priorities. If we are required to work excessive hours today and everything is priority in peacetime, where is the flexibility we will need when an emergency hits? I suspect there will not be much working room.

These questions are posed so that all who are responsible for the logistics support of military forces will ponder their responses and examine critically what needs to be done to reach the objective. The logistics system of today must meet the 1939 criterion, "Will it work in war?"

Joseph May, Professor
Air Force Institute of Technology



The job before the United States in 1945—convert a massive industrial capacity, after years of war production, back to a peacetime economy. (Kelite Corp, *Fortune,* June 1945).



(Continued from page 104)

materiel while preparing forces for intervention. Again, the American industrial base was not capable of producing enough to meet logistical requirements in Korea. And again, "neither the Far East Command nor the Department of the Army appeared to have any prepared plan for support of military operations in Korea" (3:649). But also like World War II, once the United States decided to commit men and equipment to support the Republic of Korea, the logistical advantage was to swing toward the South.

For the most part, Korean logistics was a replay of World War II. In fact, the distribution of supplies was very similar, and most of the equipment used was taken from large supply stores left in the Pacific from World War II. It has been rightly asserted:

> . . . there could have been no Korean War without World War II preceding it. Stocks being maintained in the various materiel reserves were made up almost entirely of WW II supplies, for there had been virtually no new procurement of most items since the end of WW II (3:649).

Despite the great similarities of World War II and Korea, some changes and new problems were to impact logistical operations.

Korea: Off to a Bad Start in Logistics Performance

First, it was just bad luck that the North Koreans launched their attack in the last days of a fiscal year, for this was a time when the Air Force was strapped for funds to meet sudden increases in the cost of operations. Then, too, the Far East Air Forces (FEAF) were caught unprepared, with enough spare parts for peacetime use but not nearly enough for war. When war did break out, supplies were soon depleted, and for awhile, FEAF had to support itself from hand-to-mouth.

At that point Air Force supply problems were really just beginning. Understandably, the Air Force was anxious to airlift supplies to Korea as fast as possible, but in the haste of the first few months, there were too many high-priority requests, resulting in confusion and an excessive backlog. Gradually, Air Materiel Command (AMC) and the Far Eastern Command were able to straighten out some of the confusion through closer cooperation, but other problems were beyond their control. In Korea, the Air Force found itself once again requisitioning common stock from Army depots, which meant the Air Force depended not only on another supply system but also on a supply system quite different from its own.

In the midst of all the frustrations and disappointments, USAF supply operations in Korea did achieve some notable successes. When, for example, the F-86 pilots were desperate for external fuel tanks, the supply managers came through. Furthermore, any verdict on supply support in Korea must take into account the fact that the United States and the Air Force had many commitments all over the world. Toward the end of the war, the Air Materiel Command was shipping more than 4 million tons of materiel to hundreds of bases and other military installations in the United States and abroad. At the same time, the command was also furnishing substantial logistics support to the countries in the North Atlantic Treaty Organization.

But with all that said, it is also true that the Air Materiel Command and the operational units in Korea were far from satisfied with the support provided during the war. What bothered Air Force officials was not so much the amount of support—which was generally adequate—as the manner in which the support was given. They complained that requisitioning procedures were a bureaucratic maze, the logistics function had failed to develop a smooth routine for furnishing supplies, and instead they relied on too many crash projects. While such projects had indeed sped up supply actions, they had also been wasteful and could have been avoided by careful planning and coordinated staff work. After 3 years of war, the Air Force had learned once again how much it depended on its logistics organization.

But for their part, the logisticians had also relearned an old lesson: the efficiency and effectiveness of their support depended on mastering the techniques of gathering and analyzing information, discerning trends, and accurately forecasting the needs of the Air Force. As the Air Force grew in size, the scope of its responsibilities increased, and it acquired ever more advanced weapon systems, the task of logisticians became all the more important and all the more complex. Their ability to support the Air Force was a question weighing heavily on their minds at the time of the Korean War, causing them to reexamine the logistics system in a new light.

Logistics: An Illustrated History of AFLAC and Its Antecedents, 1921-1981

The most significant new challenges of the Korean conflict involved vehicles. The lack of roads and railways made it essential to develop replacement vehicles for the World War II vehicles still in use. Although the new vehicles were bigger and somewhat more durable, the cost was more than three times as much as their predecessors, and they were just as difficult to maintain. Another, more general, change concerned the fact that Korea was a United Nations (UN) conflict, and troops from other nations had to be resupplied along with the US forces. Problems ranged from lack of standardization of weapons to elimination of pork from the mess provisions of Muslim troops.

One final significant change involved the development and common use of helicopters:

> The helicopter was ideal for delivering supplies to small isolated units and for evacuating casualties from areas inaccessible to surface motor transportation. The demand for helicopters in Korea became so great that they were a critical supply problem throughout the war (3:628).

Helicopters, combined with surgical teams close to battle areas (Mobile Army Surgical Hospital), played a major role in reducing the number of deaths due to battle wounds.

These are only a few of the changes in logistics during the Korean War. Other factors will be discussed in the next section, which will present a topical analysis of the key logistical factors of the industrial base, acquisition, requirements, distribution, and maintenance of the Korean War.

Industrial Base

Despite the shaky peace that existed after World War II, armed service budgets and manpower were reduced, and a period of retrenchment evolved (3:589). The outbreak of the Korean War again found industrial production unready to support a large army. At first, it was believed the North Koreans could be pushed back using supplies left from World War II. This plan seemed to work until the Chinese unexpectedly joined forces with the North Koreans. The Chinese Communist attack that provided stimulus to the US rearmament program (3:621).

Helicopters came of age in Korea, adding new dimensions to the movement and rescue of front-line forces.

The industrial buildup for Korea, however, was much different from that of World War II. First, the policy of *creeping mobilization* replaced the *total mobilization* of World War II. That is, industrial mobilization would be partial rather than total and would be accomplished with the least possible disruption of the domestic economy (3:651). Despite the unfavorable sound of this policy, it represented a conscious effort to improve the overall US response. As Dr Huston explained in an article for *Military Review*:

> This was an attempt to get away from what had been too frequently the American reaction of living from crisis to crisis with buildup and letdown. The policy of creeping mobilization represented an attempt to establish a plateau of preparedness which would furnish a more satisfactory continuity of strength with which to meet not only current threats but also those which would be certain to arise in the future (8:135).

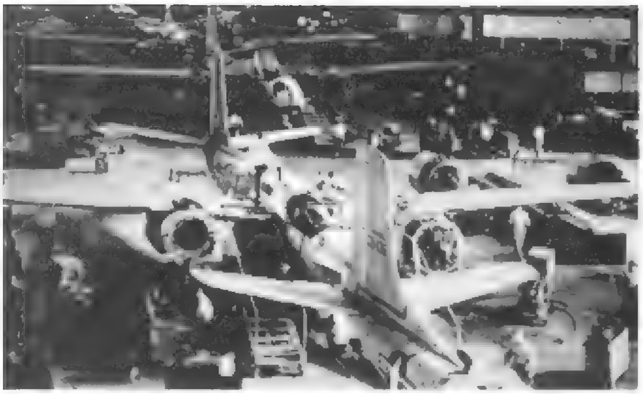
Another important logistics policy was the broad industrial production base that spread war materiel orders out to several companies running single shift production lines instead of single producers running production shifts around the clock. This program cost a little more in terms of dollars and management but aligned industries to rapidly meet short-term limited wars and allowed for long-range industrial preparedness in the event of all-out war.

> Creeping mobilization and the broad production base probably were the fundamental logistical concepts of the Korean conflict. They shaped the whole war effort by treating the war in Korea as a limited war while preparing for a total effort should that become necessary (3:651).

Requirements

As in the industrial base, the Korean requirements system operated in much the same way as in World War II, only on a much smaller and less complex scale. Perhaps the most significant change in the requirements process during the Korean conflict reflected the hard lesson learned during World War II that materiel mobilization should take precedence over personnel mobilization since production of equipment required much more lead time. This principle was carried forward. resulting in the stockpiling of entire tables of allowances to meet the needs of an infantry division. The practice greatly reduced the waiting time from request to delivery.

Not every facet of the Korean requirements system ran smoothly. In fact, within 3 weeks of the start of the conflict, it became obvious that many of the lessons learned during World War II had been forgotten. More than one-half the initial requisitions were listed as top priority. Since this priority designated air transportation, large backlogs of shipments quickly accumulated in US ports because air cargo capabilities could accommodate only a fraction of the amounts requested.



A major reformation of air logistics was underway as the Air Force transitioned from the propeller era to an all-jet fleet. B-26 Invaders gave way to F-84 Thunderstreaks at Ogden AMA.

The problem of stating realistic priorities was eventually corrected, but one can rightly determine that such mistakes made under more serious circumstances could prove costly, if not fatal. But if identifying requirements during the Korean War greatly resembled World War II requirements, the acquisition of war supplies for forces in Korea reflected quite a few new factors.

Acquisition

Korean War acquisition differed somewhat from that of World War II. Although stateside acquisition of supplies and equipment remained essentially the same, the nature of limited war made other avenues of acquisition more available. To begin with, World War II surplus equipment, including food rations, had been stockpiled in Japan and other parts of the Pacific and was readily available for use (8:33).

The fact that limited war allowed the use of allied countries located closer to the war zone for support was also of great benefit. Japan was now such an ally. For one thing, the close proximity of Japan permitted the United States to stockpile domestically made supplies in a location not subject to being attacked or overrun by the enemy. Japan's growing industrial capacity and available labor force provided another second source for contracting. Although Japanese sources were used to repair and rebuild reparable parts and equipment during the early months of the war, the principal source of military production was in the United States. However, local procurements from merchants and manufacturers in Japan and Korea were important sources for filling gaps between supply and demand throughout the war (3:634). Critical items such as landing net clips, manila rope, sandbags, and life preservers were easily acquired from local manufacturers. Despite all the industrial, requirement determination, and acquisition accomplishments of the World War II and Korean eras, perhaps none of these areas compares with the accomplishments made in the distribution of supplies.

Distribution

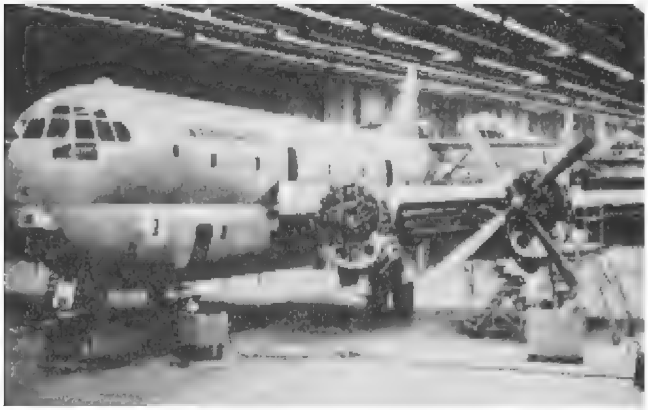
In general, Korean distribution was conducted based largely on the experiences gained in World War II. While initial equipment was distributed from Japan, US shipments to Korea were directed through coastal ports of embarkation and delivered either directly to Korea or to Japan for storage and resupply.

Initial shipments to Korea were rushed, and normal procedures were mostly ignored. Supply was again put on an automatic basis corresponding to that used early in World War II. Because of the lack of positive control of distribution, ships were used uneconomically, supplies piled up in harbors, and many noncritical items were shipped ahead of more important ones (9:56). Within weeks, however, a logistical command was established in Korea to organize information and bring logistical activities under control. This command functioned much like the ComZ organization in Europe during World War II. Early distribution to forward areas was complicated by rapid movements of combat forces and lack of associated transportation systems. However, as the combat movement slowed down, supply distributions caught up rapidly, and within 4 months of the outbreak of hostilities, prescribed levels of supply were established and maintained (9:56).

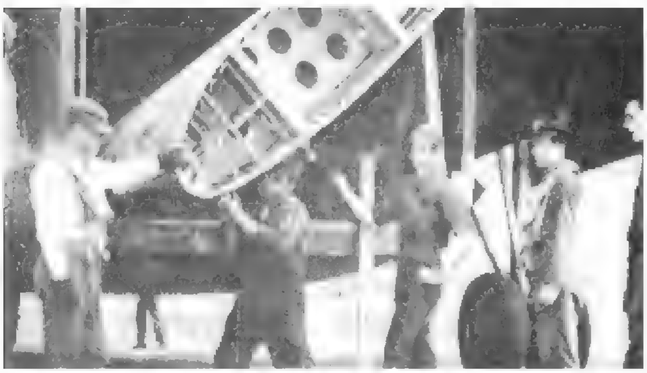
Still, several distribution problems persisted, in particular the land transportation difficulties. Although major depots were established at Korean port facilities, intermediate depots as adopted in World War II were not set up. This limited the ability to move supplies forward. Also, distribution responsibilities were split between several organizations, resulting in numerous coordination problems. For example, shipments from the United States conflicted with shipments from Japan. Likewise, railway movements were not coordinated with ship arrivals in Korean ports. Despite these problems, adjustments in distribution control were made. In the words of Department of Army historians, "The Eighth Army (in Korea) was one of the best fed and best clothed US armies ever engaged in combat" (9:60).

One final distribution factor that must be addressed is the evacuation of casualties. Because of the increased numbers and effectiveness of weapons, more injuries were produced and presented a more significant retrograde traffic factor than in previous wars. Additionally, new medical capabilities brought new responsibilities for preserving the lives of men wounded in action. The War Department General Staff explained the World War II system that carried over to Korea:

> The system of medical care for battle casualties took on new characteristics in World War II. Originally it was intended that general hospitals, miles behind the combat lines, would provide definitive medical care for soldiers wounded in action. The system of battalion and regimental aid stations and division collecting and clearing stations was geared to a concept of static warfare. In World War II, evacuation hospitals, field hospitals, and mobile surgical hospitals worked very close to the combat front, introducing a new concept of medical treatment. The wounded were



A C-97 on the repair line at Oklahoma City AMA. Depot maintenance in the 1950s was based on the inspect and repair as necessary concept. Rather than totally disassembling and refurbishing aircraft and returning them like new, the new concept was to only fix what's broke. The payoff: faster turnaround and less cost. A companion program, Operation Bench Check, encouraged users to more thoroughly check out component failures and repair them at lower levels. The combination of these programs reduced maintenance backlogs considerably.



Air resupply for the air fleet. A C-47 wing bound for Korea is disgorged from a C-119 Flying Boxcar.

> moved promptly from the front line to these hospitals. Here initial wound surgery was performed before a patient was sent to the rear areas. This surgery was intended only to remove the immediate danger to the patient's life. Reparative surgery was subsequently performed at general hospitals located in the communications zone. The third phrase, reconstructive surgery and rehabilitation, was performed at general hospitals in the United States. This system of surgical treatment contributed materially to the fine World War II record of lives saved and also prevented many cases of permanent disability (6:125-126).

Within combat zones, wounded were removed from front lines using litters, amphibious vehicles, jeeps, ambulances, and (in limited instances) light aircraft. Those patients moved by surface transportation to rear area hospitals were under control of the ComZ commander, while all air evacuations within theaters were the theater commander's responsibility.

In all, the mobile hospital and evacuation system of World War II required considerable effort but resulted in lowering the fatality rate of men wounded in combat by one half of that experienced in World War I (6:121).

Similar success was achieved in the Korean conflict. Generally speaking, the hospitalization and evacuation system used in Korea was about the same as had been used in World War II. Probably the most significant developments in this connection, according to Huston, were the general use of Mobile Army Surgical Hospitals, the use of helicopters for battlefield evacuation, and the general reliance on air transportation for the evacuation of casualties to Japan and to the United States (8:112). The increased dependence on airlift will be further discussed in a later section.

Maintenance

Difficulties in maintaining combat equipment in Korea appeared from the outset of hostilities. The added strain put on vehicles by heavy and constant use over poor roads and mountainous terrain, mechanical weaknesses in some tank models, and a period of intense artillery fire contributed to these difficulties. But much of the trouble in the early months of the conflict seemed due more to a lack of well-trained men to handle the necessary organizational and field maintenance than to defects in the design or strength of equipment itself. Most of the equipment was of types that had held up well under strenuous combat conditions in World War II. Huston points out the lack (or misuse) of tank repairmen in the infantry regiments was especially noticeable. Another difficulty, at least until 1952, was the inevitable shortage of spare parts. This was an especially acute problem for the great variety of highly specialized engineer equipment that had to be kept continuously in operation (8:31).

(Continued on page 126)

Maintenance Cultures

Another confusing logistical problem resulted from UN and ROK operation and maintenance of equipment. The ROK forces particularly were handicapped by a conglomeration of vehicles, a lack of sufficient organic maintenance organization and control, and a lack of maintenance equipment. Replacement parts were lacking for obsolete ROK materiel, and Thai and Filipino troops were judged incapable of handling medium tanks or cold weather maintenance. The Greek troops had so little experience with mechanization that they drove many of their vehicles upon debarkation from Pusan to Suwon, some 250 miles with little or no grease. While the Dutch provided few vehicle or weapons maintenance problems, the French were so accustomed to cannibalizing their US-supplied World War II equipment for spare parts that they had to undergo extensive training to learn new maintenance standards and techniques for replacement equipment.

B. Franklin Cooling
"Allied Interoperability in the Korean War,"
Military Review, June 1983

Supply Systems

Three separate and parallel supply systems functioned during the Korean War. The principal one naturally was that of the United States since it provided the bulk of the clothing, rations, equipment, and weapons used by all US and attached UN units except those of the British Commonwealth. The British maintained a separate supply line, while the ROK forces maintained their own, with both Allies receiving a portion of their supplies from US sources.

Thus, the principle of providing supplies on a reimbursable basis became the underpinning for Allied logistics. It required EUSAK to establish a method of materiel supply, maintenance of records, and a system of accountability so that the US Government could later request reimbursement based upon adequate and accurate information. In addition to the reimbursement question, problem areas of importance also included clothing, dietary needs, vehicular and weapons maintenance, and medical evacuation.

B. Franklin Cooling
"Allied Interoperability in the Korean War," *Military Review* , June 1983

Abusing the Priority System

Within 3 weeks of the start of the Korean War, the backlog of top-priority shipments had built up to more than could be airlifted in 2 months. More than half the requisitions received from Korea were listed as top priority and designated for air transportation. Yet our air cargo capability could accommodate only a small fraction of that amount. Flooding the supply system with top-priority requisitions was self-defeating. Cargo jammed aerial ports of embarkation and sat there for months, although it could easily have been delivered in less time by surface transportation.

Two years after the start of the Korean War, an Army general inspected the port of Pusan. He reported that, despite prolonged hard work, one-fourth of the supply tonnage stored there had still not been sorted out. As supply personnel did not know what these supplies were, obviously they could not be issued.

Major General Jonas L. Blank
"The Impact of Logistics Upon Strategy," *Air University Review*, March-April 1973

Roots of Wholesale Logistics

The fundamental logistical problem for the Air Materiel Command was to be able to support military forces at the same speed with which they could be employed tactically or strategically. During World War II, it had become painfully apparent that the mobility of airpower was too often shackled by the limitations of surface logistics, stodgy communications technology, and manual record keeping. In mid-1945, delivery of an item requisitioned by US forces in Germany took an average of 106 days. The advent of jet aircraft made the disparity between supply and striking speed even more acutely frustrating. Moreover, the long pipeline time meant that more items had to be purchased, consuming budget dollars that were needed for other purposes. The Air Materiel Command elected to attack this sluggishness with the weapons of airlift in combination with automation in its various forms—electronic data processing, communications, inventory control, materiel handling, and manufacturing methods.

Many of the policies and actions that the Air Materiel Command undertook during the period following the Korean War had their origins in the concept known as *Logistics for 1956*, which was generated by Air Force headquarters during the early 1950s and endorsed by the Chief of Staff in February 1953. This package of ideas called for ending the practice of prestocking supplies overseas, reducing the workload at overseas depots, and reducing the amount of materiel in the supply pipeline at any given time. The objective was to place as much of the peacetime stocks as possible in the hands of the operational commands, with the remainder located where they could be made available promptly.

Logistics: An Illustrated History of AFLC and Its Antecedents, 1921-1981

Clothing and Food

Logistics complexities found expression in such basic areas as clothing. For one thing, the question of US sizes caused difficulty for many smaller UN soldiers. The desirability of maintaining a single supply system for combat suggested the practicality of standardization with the clothing of the US forces. Some UN troops, again excepting the British Commonwealth, attempted to replace only their worn-out supplies with US items. In many cases, such as the French, the essential logistical problem became one of indoctrination in US clothing sizes as well as the limitation of US depots.

There were instances of inadequacy; the onset of winter and the rapid pace of tactical situations produced much suffering despite adequate preparations beforehand. As one Argyll highlander phrased it:

> Apparently, the British battle dress was not thought adequate to a Korean winter, and the Scots were happy that dependency on the supply system of the American divisions permitted windproof jackets and fur hats to be issued to Commonwealth division people.

But some other UN contingents needed extensive training in the use of US cold weather gear, and some US equipment simply proved too complicated for them to operate and service. This included liquid-fuel/high-pressure cooking and heating apparatus, water purification techniques, and insect repellent material. UN personnel actually died from confusing fuel tablets with food or salt tablets, while immersion heaters were thought to be part of shower units and helmet liner neckband were mistaken for ties. Words like *poncho*, *shelter half*, *cargo pack*, *kitchen fly*, and *pile liner*—while familiar to European Allies—were quite foreign to Thai troops.

World War II experience in the Italian campaign had conditioned Korean War planners to the anticipated *cuisinerie* difficulties of the multinational force. However, food preferences and religious customs actually proved far less difficult than expected, although some modifications and special rations were developed to meet the problem. ROK forces had their own prewar-designed food ration but had to draw on US stocks when shortages occurred in their war-ravaged homeland. In addition, the Koreans lacked an individual combat ration when their forces deployed beyond the reach of field kitchens. This led to the use of Japanese food specialists in developing a special Korean combat ration.

B. Franklin Cooling
"Allied Interoperability in the Korean War," *Military Review*," June 1983

The Ridenour Report: Splitting R&D from Logistics Support

For all its many research projects, the Air Materiel Command was still primarily a logistics support organization, not a research institution, which is to say that the command's basic interest was to make available and maintain the best possible equipment for the using organization. This meant that research at the Air Materiel Command was inevitably oriented toward the development of new and improved equipment and hence toward service and production engineering. It also meant that, more often than not, basic research took second place to applied research and that over a period of time the technological base—so crucial to future military superiority—would necessarily suffer.

In 1949, a special committee of the USAF Scientific Advisory Board, under the chairmanship of Dr Louis N. Ridenour, examined this dangerous trend and recommended that research and development be separated from production engineering and placed in an organization of its own. In full agreement, the leaders of the Air Force proceeded to organize a separate command for the research function. This was a tremendous task involving personnel, scores of facilities, and a substantial amount of equipment. But with the establishment of the Air Research and Development Command in April 1951, the transfer was completed, and Air Force research and development had a new home.

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"We Shall Return"

Ironically, some of our logistical ineptitude in World War II paid an unexpected bonus during the Korean War: some of the equipment and supplies abandoned on the Pacific Islands were gathered up, renovated, and put to use. That sometimes happens in our unpredictable business. An anecdote by a British officer about the Boxer Rebellion in China described the advantage they enjoyed through lack of communications. He told of the desperate plight of their scattered forces who were unaware of how ghastly everything was and so fought on to a happy conclusion. In his opinion, half a dozen radio transmitters would have brought about a catastrophe.

Major General Jonas L. Blank
"The Impact of Logistics Upon Strategy," *Air University Review*, March-April 1973

A *Push-Pull* Combination Struggles Through

The Korean War (25 June 1950–17 July 1953) had its own special peculiarities, which affected logistics support and the distribution of supplies and equipment. The hasty nature of our response, the proximity of Japan as a major support base, rugged Korean terrain, and poor in-country transportation facilities were some of the key factors aiding and/or inhibiting our logistics success (2:13). The United States had entered the Korean War with insufficient and ineffective logistics planning.

> The piecemeal nature of the initial US action was reflected in the evolution of the logistics system. At first, there was a great deal of "movement" but very little "control." Supply procedures in effect in the Far East Command (FEC) before 25 June 1950 were largely ignored. Normal requisitioning and issuing procedures were suspended; in many instances, unit trucks simply backed up to the depot warehouses and were loaded with the needed equipment. There was no time to make out the prescribed papers (2:13).

Therefore, as in World War II, the push distribution approach was used initially to provide supplies to combat units in Korea. Bulk shipping was used to maximum resources available, and resupply was automatic. Later, also as in World War II, overlapping unit requests, but not formal requisitions, prompted duplication and inefficient supply actions. "Inevitably, therefore, ships were used uneconomically and piled up in the harbor of Pusan, while some noncritical items were shipped ahead of more important ones" (2:14).

Organizationally, the Second Logistical Command took over the in-country central supply system as early as September 1950. The Japan Logistical Command (JLCOM), formerly the Eighth Army (Rear), was the logistics support unit for the Eighth Army and other UN forces. Following the initial push of supplies from support bases in Japan, resupply of materiel came from the CONUS supply sources. Initially, the resupply to JLCOM and directly to units in Korea was by a push system. By October 1950, JLCOM requested the automatic resupply be replaced with a requisitioning system except for certain specified supply items. In transportation, airlift was used to satisfy emergencies but proportionally moved very little materiel in the Korean War. The Military Air Transport Service provided intertheater airlift, while the Far East Air Forces transported intratheater requirements. Sealift, controlled by the Navy's Military Sea Transport Service, moved most of the property from Japan to Korea and from the continental United States to Japan and Korea (2:15).

As the UN forces moved northward, they encountered intratheater problems transporting supplies from the port at Pusan overland because of the rough terrain and the poor inland transportation network. Combat forces received materiel from Japan faster by sea than overland from Pusan. Additionally, distribution problems resulted from the entry of the Chinese Communists in the war in 1951 and the subsequent retreat south by UN forces. Despite this fluctuating front, the supply situation stabilized early in 1951 (2:16).

Procedures agreed upon by JLCOM and the Eighth Army in Korea (EUSAK) provided more efficient use of shipping and a better system of supply support. Essentially, the agreement established a 45-day maximum stockage level in Korea. JLCOM also forecasted requirements based on monthly EUSAK requisitions. In essence, a system was established to limit supplies to those actually needed and to improve inventory control and distribution efficiency (2:16).

As previously mentioned, land transportation (rail and highway) was not very effective. Although seaport congestion did occur, the ability to clear assets through ports often surpassed the ability to transport materiel overland to the combat troops.

> It was largely owing to the transportation (ground) deficiency that many depots were established at the ports. This practice in turn contributed to port congestions. Moreover, the absence of the system of intermediate depots adopted in World War II resulted in certain loss of momentum in forwarding supplies. In some instances, combat units stationed *expediters* near the depots to make certain needed supplies moved forward (2:17).

Despite problems with ground transportation, supplies, in adequate quantities, were provided to combat forces during the last 2 years of conflict. The combination push-pull distribution approach seemed to function effectively when compared to the earlier push system.

Notes

1. Director of the Service, Supply and Procurement Division, War Department General Staff. *Logistics in World War II*, Washington, DC: Government Printing Office, 1947.
2. Joint Chiefs of Staff, Historical Division, *Movement Control in Three Wars: World War II, Korea, Vietnam*, Washington, DC: Joint Chiefs of Staff, March 1973.

Major Gary F. Hollums
"Distribution Approaches: A History and a Suggestion,"*Air Force Journal of Logistics*, Fall 1984

(Continued from page 122)

Airlift 1941-1955

Since the use of aircraft for logistics purposes gained common acceptance during this time period, a few comments from the historical perspective are appropriate.

During the early campaigns of World War II, cargo aircraft were recognized as useful for tactical airdrops of airborne forces and were sometimes looked to for emergency deliveries of supplies. The capability to travel great distances rapidly and get to otherwise inaccessible areas added new dimensions to warfare tactics and planning. However, in logistics terms of total tonnage carried, air transport contributions seemed almost insignificant, and future implications for airlift seemed overexaggerated (3:512,670).

The high cost of air cargo movement and the low reliability of airlift due to maintenance (air and ground aborts), weather delays and cancellations, and other planning/coordination factors made logistical airlift use very limited. For example, it had been expected that airlift would play an important role in providing supplies to forces during emergency conditions. However, when the supply need was the greatest during the Allied rapid advance across France, airlift participation was far less than expected. Although requests were made for airlift to support delivery of gasoline, nearly all cargo aircraft were withheld from support activities in favor of planned airborne operations (3:528). What few aircraft were available for supply made no significant contribution due to poor planning and coordination. Bad weather, duplicated requests, and inability to bring supplies, trucks, and aircraft together in a coordinated manner caused most problems.

Later, the lack of airfields near destination zones limited large-scale supply operations. Those airfields available were taken over by fighter and bomber combat units (3:528). Later in the war, air transportation proved somewhat more effective, especially as Patton's Third Army pushed into Austria and Czechoslovakia. Some 22 percent of the gasoline and 11 percent of rations delivered to the Third Army during that time were airlifted. Much of this improved effectiveness was attributed to better coordination of supply requests and activities, but it is also true that tactical airborne plans no longer competed with supply plans for aircraft use (3:536).

One significant hindrance to tactical airlift again centered around planned airborne use. In Normandy, the ground armies moved so rapidly that most airborne plans had to be cancelled. Airborne operations and planning required lead times and could not keep up with the changes brought about by a rapidly changing scenario. Nonetheless, supplies were withheld from combat until new plans could be developed.

Without a doubt, the advantages offered by airlift (speed and accessibility) made the difference between success and defeat in certain instances. The airlift contributions made when flying essential supplies over the *Hump* into China and the emergency airlift support of forces fighting in the Dardanelles are particularly cogent examples. But perhaps the most remembered airlift accomplishment occurred after World War II—the Berlin Airlift.

A C-82 loads a small bulldozer through its convenient empennage clam shell doors. Specialized airlift capabilities were improved in the aftermath of the war.

Clearly, the Soviet blockade of Berlin left no peaceful alternative for resupplying that city. The accomplishments made by airlift during the yearlong blockade were indeed awesome. At one point, airlifted supplies actually exceeded the tonnage rates for supplies delivered to Berlin by rail and water before the blockade was imposed (3:596). But the cost of this superhuman effort has often been overlooked. Airfields at both ends of the airlift route had to be expanded, which itself caused many additional flights to deliver the construction materials needed. Aircrew quarters had to be built to support the increased numbers of crewmembers and support personnel. According to Huston, "It took three oceangoing tankers and 1,500 rail tank cars a month to get the gasoline (more than 15,600,000 gallons) to the air bases" (3:596). In all, the total support costs involved in the Berlin airlift operation were staggering and made overreliance on airlift for anything other than emergency resupply seem impractical.

Airlift during the Korean War found even more routine uses, but even then, the amount of general and high-priority cargo delivered was insignificant in terms of total tonnage moved. Even at its peak, airlift represented less than 1 percent of the total cargo shipped in support of the war effort.

> In view of the limited tonnage capabilities and high cost, there still was serious question as to the role air transportation should play in the general military transportation system of the early 1950s. Even speed, when the cargo involved more than a few tons, was better served by sea transportation (3:670)

Huston concluded that, in light of the historical use and capabilities of airlift, the major contribution of air transportation would probably be "in providing the means for adapting to breakthrough and rapid thrust," such as during Patton's thrust through France (3:670).

In summary, the logistics role during the campaigns and battles of World War II and Korea evidenced a turning point in recognized significance. As armies became more sophisticated, logistics played an ever-increasing factor in waging wars. This truth will again be seen as we examine US involvement in Vietnam.

Early Wargaming

RAND's work in the application of man-machine MSGs (models, simulations, and games) to problems of both operational and experimental interest was carried out by the Logistics Systems Laboratory (LSL), primarily in the late 1950s. Various groups within the Department of Defense had already sponsored considerable research on problems of logistics and inventory management. There was, however, a large gap between the results of this research and their practical implementation. LSL was a man-machine approach to help bridge this gap. Basically LSL was intended to provide a sufficiently reliable representation of the real-world environment of Air Force logistics systems to permit testing and comparison of policies and procedures. It would also attempt to assist in transferring the results of research, modified by experience gained in the laboratory setting, to operations in the real world.

Laboratory Problem (LP-I) was LSL's first major task. It was designed to test logistical polices and procedures for the Air Force and indicate ways of implementing them. The potential polices were incorporated into a system (Logistics System 2) and compared with the actual configuration (Logistics System 1). The two models were evaluated under identical circumstances described in terms of numbers of aircraft to be maintained, flight programs, and other conditions. The comparative effectiveness of their polices and cost was also calculated. Next, a rapidly changing aircraft program was simulated. The experiment provided for phasing aircraft in and out of inventory over a 5-year period, during which use factors—frequency, duration, and type of missions flown—for each aircraft were varied in ways assumed to be realistic. The properties of the simulated aircraft were derived from a study that selected 800 out of a possible 15,000 parts to reflect differences in price, demand, reparation, importance, and so forth. A special malfunction model was designed and used to give identical malfunction patterns for similar flights using either logistics systems.

Each simulated day took about an hour of running time in the laboratory. The experiment ran for 14 simulated quarters, during which two wars were simulated; it took 4 months to conduct. The staff of LSL included about 30 professionals, 20 clerks, and various supporting personnel to program and operate the computer. Fifteen players operated each of the two systems. Work began on LP-I in early 1957 and continued until the end of the year. In the fall of that same year, work commenced on Laboratory Problem II (LP-II) and continued until late 1958. Unlike its predecessor, LP-II stressed the development of systems; specifically, it was an attempt at a study of the ballistic missile system, which had not yet been fully developed. The basic aim of LP-II was to help develop a set of operating and support policies for the evolving system. In 1960, the Air Force created a team to evaluate LP-II and the techniques it had used, with the following major conclusions being reached:

1. Laboratory simulations can be valuable tools for use in evaluating the design and application of military systems.
2. Benefits accrue from a reduction in the time and cost of system-development processes.
3. Combat effectiveness can be improved through better design of systems.
4. Laboratory simulation can be useful in generating and comparing certain classes of operational and logistical systems and policies.
5. Laboratory simulation does not eliminate the need for operational tests.
6. To be effective, facilities for laboratory simulation should be in close proximity to Air Force system-project offices. Constructing a single laboratory-simulation facility for the entire Air Force seems to be unsatisfactory, but there seem to be practical advantages to concentrating work in a few major installations.
7. Simulations of systems for Air Force decision-making purposes should be performed in house rather than by contractors.

Garry D. Brewer
Martin Shubik
The War Game

Scientific Study of War

If the study of war in the past has so often proved fallible as a guide to the course and conduct of the next war, it implies not that war is unsuited to scientific study but that the study has not been scientific enough in spirit and method.

It seems hardly possible that the authoritative schools of military thought could have misunderstood as completely as they did the evolution that was so consistently revealed throughout the wars of the 19th and early 20th centuries. A review of the record of error suggests that the only possible explanation is their study of war was subjective, not objective.

Even if we can reduce the errors of the past in the writing and teaching of military history by soldiers, the fundamental difficulty remains. Faith matters so much to a soldier in the stress of war that military training inculcates a habit of unquestioning obedience, which in turn fosters an unquestioning acceptance of the prevailing doctrine. While fighting is a most practical test of theory, it is a small part of soldiering; and there is far more in soldiering that tends to make men the *slaves of theory*.

Moreover, the soldier must have faith in his power to defeat the enemy, hence to question, even on material grounds, the possibility of that successful attack is a risk to faith. Doubt is unnerving save to philosophic minds, and armies are not composed of philosophers, either at the top or at the bottom. In no activity is optimism so necessary to success, for it deals so largely with the unknown—even unto death. The margin that separates optimism from blind folly is narrow. Thus, there is no cause for surprise that soldiers have so often overstepped it and become the victims of their faith.

The soldier could hardly face the test defined in the motto of the famous Lung Ming Academy, a motto that headed each page of the books used there: "The student must first learn to approach the subject in a spirit of doubt." The point had been still more clearly expressed in the 11th century teaching of Chang-tsai: "If you can doubt at points where other people feel no impulse to doubt, then you are making progress."

B. H. Liddell Hart
Why Don't We Learn From History?

Chapter Five

Technological Modernization: Passageway to the Eighties

1955-1980

Transitioning to the Sixties

The period after World War II and the Korean War saw changes in the basic philosophy of American military policy and defense. Rapid changes in technology dictated the need for changes in strategy. In addition, the United States now recognized itself as a global power, with interests and objectives to protect around the world. This new role led to adaptations in how basic logistical functions were carried out.

Acquisition

With technology surging ahead in the 1950s and 1960s, the acquisition of major DoD weapon systems went from the high-volume, low-unit cost of World War II to a complex low-volume, high cost structure (17:20). In the previous two major world conflicts, mobilization had been a driving imperative. Men, weapon systems, and materiel were rapidly mobilized at the start of and during these wars to meet the requirements of the war effort. Because of the strategic geographical isolationism of the United States, sufficient time was always available to mobilize these forces and move them as needed to theaters of conflict. After each major conflict, however, the first order of business for the United States was to drastically draw down military forces and budgets to get them back to peacetime levels.

With the technology of the atomic age, new weapon systems, such as the intercontinental ballistic missile and the long-range jet bomber, were brought online. These weapons had such speed, range and destructive capabilities that a mobilization concept for the United States was no longer adequate (17:21). To meet the new technology threat, the United States had to maintain, for the first time in its history, a large standing peacetime military force. With such forces came the need for an unparalleled peacetime defense budget (17:21).

With the cost of modern sophisticated weapons systems growing, plus the long lead time from the conception of a system to its operational deployment, the concept of exceptional, centralized management of major weapon system acquisition became the DoD standard in the late 1950s and 1960s (11:13). Program managers would be in charge of the development and production of major defense systems and charters would provide them sufficient authority to accomplish the objectives of programs (11:13).

Industrial Base

At the same time that the acquisition function of logistics was undergoing a philosophy change, the industrial base capability of the defense industry was drawing down. Again, during World War II, the rapid mobilization of industry had played a major role in the successful war effort. The concept of using planned procedures had helped to alleviate some of the problems of production startup or changeover to meet military requirements. However, in both the Korean and Vietnam Wars, the United States did not have a national mobilization effort. These wars were fought with a guns-versus-butter approach that resulted in both the military and private industry competing for available resources (21:10). The concept of the planned producer was rarely used. The military services requested competitive bids for their various weapon systems and negotiated and awarded the contract primarily on the basis of price, not particularly on the basis of whether a contractor had the skill, know-how, or resources to produce a required system or item. As a result, some programs experienced long production delays (21:10).

Distribution

The deactivation of US forces after World War II and Korea also affected distribution of resources. Military sealift capability was particularly hard hit. Clearly, the history of American ocean transportation has been *feast or famine* (1:10). Prior to each of its major conflicts, the United States has had to rapidly build up its sealift forces. After each conflict, the nation demobilized its ocean fleet. In 1957, the Military Sealift Transportation Service (MSTS) had 371 vessels on hand, down significantly from the 531 vessels in its fleet at the peak of the Korean War, but still more than the 135 vessels in 1965 at the start of the Vietnam buildup (1:9). The American flag cargo fleet was similarly deactivated, from a high of 1,193 seagoing vessels during Korea to 965 vessels in 1965 (1:9).

The airlift arm of the military distribution system received similar treatment after the Korean War. Obviously, air

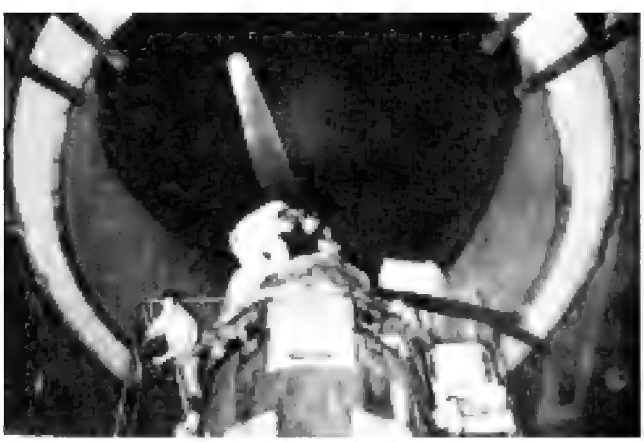
transportation requirements are quite different in peacetime than in wartime. During a major conflict, military forces need a large amount of airlift in a short time period. One expert foresaw the need for five to ten times more military airlift in wartime than in peacetime (16:5). Further, military equipment and supplies are unique and require large, specialized airlift aircraft; a large standing airlift force would thus become even more of a necessity. The basic problem then was to balance the perceived wartime threat and the necessity for preparedness with the peacetime operation and financing of such a military transportation fleet (16:9). Threats were, as always, more difficult to define and substantiate than budget imperatives.

After World War II, when overlapping logistics transportation functions became apparent in the three military Services, the concept of a single manager for each of the DoD transportation functions was realized. In 1956, the Navy was designated the single manager for sealift in DoD. Through its Military Sealift Transportation Service [later redesignated the Military Sealift Command (MSC) in 1970], the Navy had four functions:

a. Provide contingency sealift for military forces worldwide.
b. Develop plans for expanding its capabilities in peacetime.
c. Provide support for DoD during noncontingency periods.
d. Man and operate the Navy fleet support ships (1:11).

To perform these functions, the Military Sealift Command was to receive resources from four basic areas: the MSC fleet itself, the US Merchant Marine fleet, the National Defense Reserve Fleet, and foreign flag merchant marines (1:11). These four sources were to provide flexibility for DoD sealift.

The Air Force was designated the single manager for military airlift service in 1956, with the Military Air Transport Service (MATS) as the operating agency. However, a large capability for airlift was kept in the other services and even within other commands of the Air Force (1:36). Only transport aircraft susceptible to scheduled operations and engaged in point-to-point operations were included in the single manager concept at this time (15:42). The mission of MATS was to provide common user airlift service to all DoD and other government agencies:



Wright Field technicians put a new transport engine to the test in the 450-mph windstream of a 20-foot wind tunnel.

a. Between points in the United States and overseas.
b. Between and within overseas points.
c. Within the United States when needed for security or to supplement commercial carriers (15:43).

A unique funding concept was provided by an airlift services industrial fund, initially funded with $75 million. Operating expenses for MATS airlift services were paid for from this fund, and airlift users reimbursed the fund from their own operations budget (1:36).

Logistics air support among AMC depots in the United States had been established to shorten the supply pipeline and reduce stock levels of high-value items. The idea was to increase responsiveness and have a dependable logistics airlift force ready for D-day. With these objectives in mind, *logistics* airlift began operations in 1954 (15:32).

With the realization that military airlift could not handle the airlift requirements of a more demanding wartime scenario, an alternative was sought to buying more military aircraft that were not needed during peacetime operations. The Civil Reserve Air Fleet (CRAF) was formed in the early 1950s to augment MATS (1:41). The American airline industry was initially reluctant to participate, because economic realities would cause airlines to lose money. In 1960, President Eisenhower approved guidelines for a national transportation policy that spurred interest in the CRAF program. Airlines that joined were given preferential contracts, and military airlift operations in the United States that conflicted with civilian air carriers were significantly reduced (1:42).

The last of the transportation functions, land movement, became the sole responsibility of the Army in 1956, as they were designated the single manager for all military traffic in the continental United States. By 1964, the Army was the single manager for all DoD military traffic, land transport, and common user ocean terminals. Its major command was finally designated the Military Traffic Management Command (MTMC) in 1974 (1:59). The mission of MTMC was to support DoD transportation service for the continental United States. It remains responsible for movement of Army passengers and cargo into terminals, for Air Force and Army passengers through ocean terminals, and for movement of all cargo into and through ocean terminals. (1:61).

As previously indicated, the designation of MATS as the single manager for DoD airlift did not really consolidate all the DoD airlift forces. In 1960, President Kennedy's national policy change had enlarged American commitments abroad. Airlift was needed to provide the flexibility to respond to any crisis (18:42). In 1964, Air Force Regulation 23-17A redefined the role of MATS to include assault and airhead operations, and airlift now was to move troops and equipment from the United States directly to the combat area (18:48). The realization that airlift was an important weapon for the projection of US power was brought to fruition in the mid-1960s when MATS became MAC—the Military Airlift Command, a major command of the Air Force.

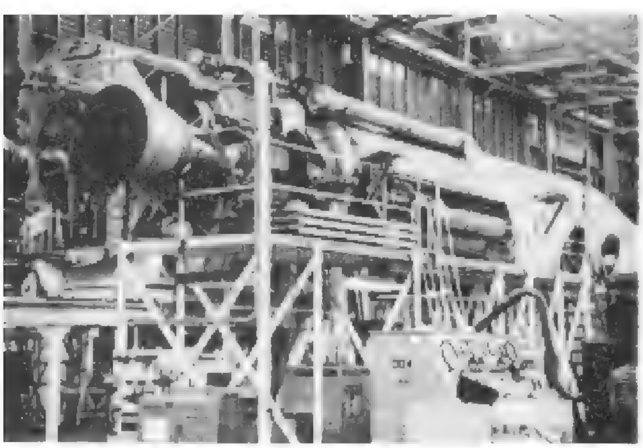
Belief the national military airlift network needed reorganization to better perform the national airlift mission resulted in consolidation of all airlift resources in 1974, when

ICBM Logistics: A New Ballgame

Providing logistical support for missiles made life considerably more complicated for the Air Materiel Command. Besides its uniqueness and complexity, there was the fact that many of them were tied to bulky ground support equipment, much more so than were aircraft. In 1958, the average missile was comprised of some 300,000 different parts, which would be subjected to tremendous vibration and gravitational forces and large differentials in temperature and air density. To guarantee they would function properly under such extreme conditions, the Air Force had to conduct exhaustive tests using sophisticated ground equipment. While the ground support effort accounted for some 20 percent of the maintenance performed on manned aircraft, for missiles, the proportion was close to 80 percent. The deployment of missiles also entailed the construction of new operating bases, frequently at out-of-the-way sites.

At the same time, though, the Air Materiel Command was in a position to exploit opportunities that traditionally had not been available for aircraft support. For one thing, missiles represented a new family of weapons and thus offered the chance for a fresh start in logistics, largely free of the need to modify or discard the inappropriate aspects of an existing system such as had grown up around many aircraft. It was feasible, therefore, to design missile support that was tailor-made for solving the problems. In addition, missiles presented the ideal opportunity to use the supply techniques being conceived as the way of the future—fast transportation, rapid processing and transfer of information, and short pipelines. Using system analysis techniques, logisticians could project the materiel and support that a weapon system would require during its service life and could plot the sequence of actions that had to occur. The information could be fed into a computer and stored at a central location regardless of whether the source was the contractor, depot, or operating command.

In November 1956, the Air Materiel Command published its logistics plan for intercontinental ballistic missiles. Basically, it was composed of principles already tested and proven on other weapon systems, particularly those outlined in the *Logistics for 1956* concept. The uniqueness of missiles and their critical importance did, however, precipitate some changes and modifications. Because of the importance of deploying missiles as early as possible, the Air Force elected to compress the research-to-deployment schedule, which entailed creating the logistics system in a more or less final form at an earlier point in the process.



An Atlas missile is checked out at San Bernardino before the Air Materiel Area was deactivated in 1966.

Airlift played a major role in the ICBM program. The C-133 could haul either the Atlas or Titan missile, provided a steely nerved loadmaster was on hand to direct the mating operation.

Also, there was the emphasis on sophisticated ground equipment, which sometimes matched the cost of the missile itself. To control costs and avoid the risk of being caught with large stocks of obsolete items if production fell short of original projections, the Air Materiel Command bought only a minimum amount of equipment until the designs became firm and delayed the purchase of expensive items as long as possible. This approach permitted the command to gather accurate data before making any commitments. The Air Materiel Command also adopted the practice of buying certain spares in an unfabricated, unassembled form and having them held at the contractor's plant until later, thus cutting the lead-time for bringing them into the inventory. This policy of keeping the inventory of spares at low levels was free of risk and workable, only if the command could provide rapid and unfailing support.

A missile was the product of many contractors and a number of AMC field units were involved in supporting the ballistic missile sites. To manage this system, the command decided to base its logistics support program on the weapon system concept and designate a single organization or unit as the system manager. The plan was approved by the other major commands and the Air Staff and was distributed in 1956. The missiles themselves would be moved by air, with some C-133s modified to carry an entire Atlas or Titan in a single trip. The Air Materiel Command decided to rely on direct support of the operational units with a minimum of intermediate stockage. General supplies would come directly from depots and common items of supplies from various weapon system storage sites with peculiar items sent from the contractors to the operational units. A transceiver network would connect the operational units, depots, weapon system storage sites, and major contractors with an electronic data-processing center located at the San Bernardino Air Materiel Area to handle information related to the missile system. The weapon system manager would control and manage the entire stock of items with the help of computers.

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both strategic and tactical airlift forces were combined under the Military Airlift Command. Three years later, MAC was made a specified command, with its commander in chief reporting directly to the Joint Chiefs of Staff (JCS) and Secretary of Defense in all matters concerning war planning, contingency operations and JCS exercises.

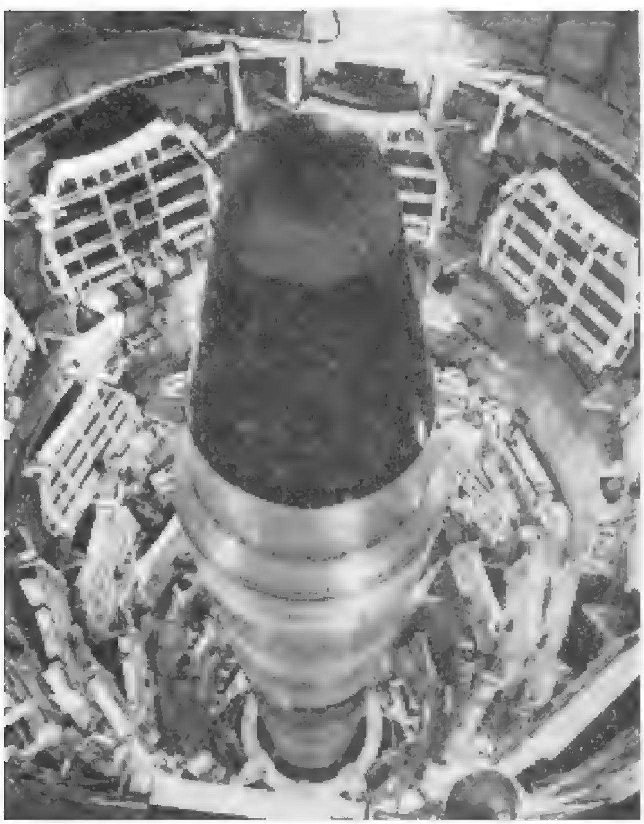
Maintenance

With new developments in technology and advanced weapon systems in the 1950s, maintenance concepts and polices underwent a revolution along with the systems themselves. The old one-man crew chief do-it-all maintenance no longer appeared viable with complex weapon systems. Specialization became the new concept and, along with it, a need for a new type of maintenance organization in the Air Force (19:35).

In September 1956, a new era in aircraft maintenance was launched with the publication of Air Force Manual (AFM) 66-1, *Maintenance Management Policy*. Initially a major command option, the regulation became mandatory Air Force-wide in 1958. It established a chief of maintenance who was responsible to the wing commander for all aircraft maintenance. The chief had a staff to assist him in centralized control, but maintenance was decentralized along functional lines, and a data collection system was included (19:38-39).

Many benefits were realized from this new maintenance organization. First, a standardized system was set up for all Air Force major commands. Under the chief of maintenance, separate maintenance squadrons were established, including organizational, field, and electronics squadrons. Second, specific goals were set for the maintenance organization. Aircraft in-commission rates, component repair standards, and aircraft scheduling objectives were among them. Third, man-hour accounting and maintenance data collection were instituted. Prior to 1958, very little data collection existed. The new regulation required daily, weekly, semimonthly, and monthly reports be collected for distribution to base managers and to managers all the way up to depot and headquarters levels. Information from these reports was used to determine the procurement of spares and equipment, levels of reliability and maintainability, and manpower requirements (19:40-41).

The delicate repair of precision guidance equipment used in the ICBM program required new maintenance techniques. Here a Minuteman memory drum is adjusted by technicians working in a dust-free atmosphere.



A TitanII missile rests in its launch tube, which doubles as its maintenance bay.

Summary

Because of new technological developments and changes in national strategy to meet the new threats of the atomic age, logistics functions in the post-World War II and Korean period became more sophisticated and complicated. The acquisition of weapon systems evolved into a program manager concept with centralized management. The industrial base of the United States was drawn down and could not keep pace with the requirements of both the military and civilian communities. The distribution function came under the single manager concept, with the Air Force, Army, and Navy becoming the operating agency for airlift, land movement, and sealift, respectively. With new and sophisticated weapon systems, the maintenance function underwent organizational change with specialization of work and centralized control the standard in the Air Force. These logistics functions would soon undergo a severe test of their capability to support American military objectives, for the longest war in US history was on the horizon.

Preview of a Desert War: The RAF in Kuwait

The supply organization learned many lessons, which were to prove of immense value for the future. It was the first occasion upon which the stockpile at Bahrein had to be used in earnest, and the near impossibility of maintaining many delicate items of equipment in a serviceable condition under the circumstances was clearly demonstrated. The radio equipment suffered badly from corrosion, and the high humidity in the Gulf seriously affected stocks of blankets and clothing as well as such perishable items as tyres. If stockpiling was inevitable, *Vantage*[1] proved not only it had to be restricted to the minimum holdings, preferably of nonperishable items but also items in a stockpile needed to be turned over at fairly short intervals. This latter requirement was very difficult to meet as, for example, in the case of *Hunter* long-range fuel tanks. The Bahrein stockpile contained a huge wall of several hundred tanks in wooden crates, some of which would certainly have been needed had Hunters been required to operate at extreme range from Bahrein. The normal peacetime consumption of such tanks was small as they lasted indefinitely if not dropped, and it was, therefore, impossible for two squadrons to turn over several hundred tanks economically. Hindsight again showed that the provisioning of these tanks had been on far too lavish a scale.

The type of container used for stockpiled equipment came in for review at this time. Most of the Bahrein stockpile had been built up by sea in a leisurely fashion, necessitating robust cases and shockproof packing for the more delicate equipment, and this applied to the majority of it. However, when brought into use, much of the equipment needed to be moved on to Kuwait by air, and then the heavy cases proved a great waste of valuable airlift. Repacking of heavily cased equipment within the stockpile not only was a waste of manpower but also exposed materiel to the elements and tended to destroy much of the proofing which had been originally applied. Experiences such as that provided by *Vantage* enabled great advances to be made by the supply organization in lightweight but shockproof packing of all kinds of equipment. Not only the packing but also the marking of cases created a number of problems from which sound lessons were learned. The planning of *Vantage*, like any other operation, had called for strict security, but there was an inevitable tendency to overdo this and allow the security to penetrate right down to the most mundane matters; every case packed for *Vantage* had a complicated set of coded numbers and letters stenciled on it indicating its contents and the part it played in the movement tables. Before unpacking or moving every case, a long classified coding list had to be consulted to check details of the particular crate. This was a lengthy and time-consuming procedure, one example of which illustrates how unnecessary much of it was. In the heat of the initial move, one supply officer at a [Kuwait operations base] had temporarily mislaid his list of code references, and it was necessary to open no less than 130 cases in order to find some cutlery for the airmen's mess. There was obviously no reason why details of such items could not have been stenciled on the case, but the imagination needed to visualize the situation that arose was lacking in the remote atmosphere of a planning office, with the result that everything had the same security grading applied to it.

Notes

1. Operation *Vantage* was the code name for the RAF involvement in Kuwait in 1961.

Air Chief Marshall Sir David Lee, GBE, CB, RAF
Flight from the Middle East

The supply of armies seldom receives the plaudits of the crowd. It lacks the glamour, the dramatics of action on the battlefield. Great quartermasters die almost unnoticed; none of us, I suppose, could say who Napoleon's Chief of Supply was. Yet an army can never be better than its supply system.

Robert F. Patterson, Under Secretary of War

Logistics in Vietnam

The war in Vietnam posed many problems and challenges to the logistics systems of the US Armed Forces. From a small advisory capacity to a full-scale war, logistics concepts had to adapt to meet requirements of a unique combat environment. Vietnam itself was characterized by lack of a national infrastructure in every logistics support area. No major transportation system existed, and ports were small and overcrowded. The existing system could not handle the high-volume traffic generated by combat requirements. Further, airports were inadequate, storage and warehousing facilities were nonexistent, and base facilities to support large numbers of aircraft were lacking. In essence, major logistics systems had to be built from the ground up.

At the start of the Vietnam War in 1965, Air Force tactical units used Vietnamese bases for support. Normal supply, maintenance, and transportation functions were largely supported by Clark Air Base in the Philippines (12:III, I-5). Vietnamese bases were characterized by minimum facilities and overcrowded ramps with adverse weather predominant and no skilled technicians or support personnel (13:III, 2-1).

Early in the war, Air Force tactical units were deployed on a temporary basis. Home bases supplied spares support and replenished *war readiness spare kits (WRSK)* from home stock. Piston-driven aircraft were assigned permanently in Vietnam and received support from only one base, Tan Son Nhut. Forward operating bases (FOBs) were set up in country and performed what temporary-duty aircraft maintenance personnel could accomplish. Heavy maintenance was accomplished at *main operating bases* (MOB) in country at Tan Son Nhut, Da Nang, and Bien Hoa (12:III, 1-5).

As the war escalated in late 1965, the Air Force began sending complete wings to Vietnam on a permanently assigned status. Before long, the three MOBs in Vietnam could not continue to adequately support the huge increase in unit requirements. The not operational ready supply (NORS) rate of aircraft consequently became unacceptable. Valuable combat time was being lost shuttling aircraft to and from the MOBs for maintenance and repairs. More MOBs had to be built if the war was not to be unduly constrained (12:III 1-8).

The new MOBs in Vietnam were built from the ground up. As a result, base equipment management officers were swamped with the demands of new units for supplies and equipment. Since the new MOBs did not as yet stock this equipment and depended on distribution from the Air Force Logistics Command, units went through their own command channels to secure items, bypassing normal supply systems (12:III 1-9). Expansion of the war, for which national mobilization would never be declared, meant rapid changes in how materiel requirements were determined and satisfied.

Requirements

To supply the new main operating bases in Vietnam, the Air Force had to disregard its system of forecasting requirements; the unit requirements were immediate. Project Bitterwine was launched to provide aircraft maintenance and base support capabilities to the new MOBs in Vietnam (12:III, 1-27). Of three methods to supply these bases, the one used most was to gather in-use equipment from other worldwide Air Force bases. Base closures during the early 1960s provided a ready source of equipment for Vietnam: by August 1966, more than $1 million of excess equipment had been identified for requisition (12:III 1-28,29).

During Bitterwine, the Air Force Logistics Command tried to group related items for shipment. With more than 339,000 line items shipped, equipment arrived in Southeast Asia piecemeal at different times and was unloaded at different ports because of saturation (12:III, 1-30). Nevertheless, Project Bitterwine accomplished its purpose of quickly supplying Vietnamese bases with needed equipment.

With the enormous inflow of supplies and equipment, a computer-based supply system had to be set up in Vietnam. Prior to the 1960s, the Air Force had allowed each major command to develop its own computerized supply system. As a result, there were numerous computers and systems in the Air Force, all of which tended to disregard the supply procedures of Air Force Regulation 67-1, *USAF Supply Manual*. This plethora of systems created many problems. First, because of the variety of systems, bases had to retrain personnel who were not familiar with a major command supply system. Second, there was an incompatibility of systems between the bases and the depot levels, thereby ensuring no interface between computer systems. And third, there was no assurance that Air Staff supply policies were being implemented by the major commands (12:III, 42-45).

To alleviate these problems, the Air Force designed a base supply operation for use with a standard computer. This system was to be used throughout the Air Force and set standardized procedures to increase supply responsiveness and allow better inventory control and management. Implemented in 1966, the new computerized supply system used the UNIVAC 1050-II computer. By 1967, the system supported 145 base supply operations (12:III, 1-45-46, 49).

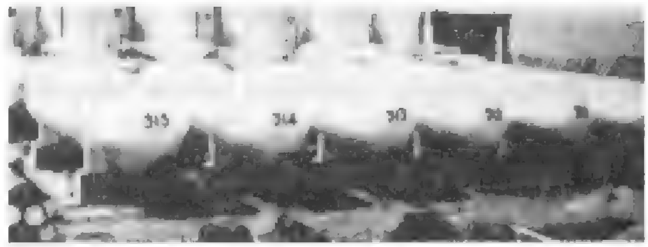
With the mass buildup of personnel and equipment beginning in 1965, the Vietnamese main operating bases, with their manual supply systems, were unable to support added logistics requirements. An effort was begun to install the UNIVAC 1050-II computer system at selected bases in Vietnam, beginning with Cam Ranh Bay in April 1966. This conversion from a manual to a computer system had its problems. One base had to close its supply accounts (except for high-priority maintenance items) for 30 days to purge obsolete items and confirm due-ins. Another base used duplicate stock data from a US base to create its stock level. Because of the difference in missions, this base had to sort out items not needed for the combat mission in Southeast Asia. Despite such problems, the new computers ultimately enhanced the supply system and its capability in Vietnam (12:III, 1-49- 53).

Along with the rapid buildup of equipment, the supply function experienced a shortage of personnel. The Air Force Logistics Command provided help with rapid area supply

Air National Guard F-106 Delta Darts undergoing maintenance at Sacramento Air Logistics Center, 1972.

An American milk plant in Qui Nhon, operated under a fixed-price, indefinite quantity contract, provided a welcome alternative to canned whole milk and powdered ice cream.

Liquid propane gas tank trucks delivered cooking gas to hundreds of locations in Vietnam.



LPG storage tanks at Nha Be. All cooking facilities were converted to operate with this fuel as of 1966.

support (RASS) teams beginning in June 1965. These RASS teams consisted of cadres of military and civilian specialists that assisted newly activated MOBs in establishing and restoring supply accounting, inventory, storage, and issue activities. Despite the RASS teams, manning problems continued, and combat logistics support squadrons (CLSS) were formed at each air materiel area to increase manning authorizations and help alleviate these shortages (12:III, 1-114-117).

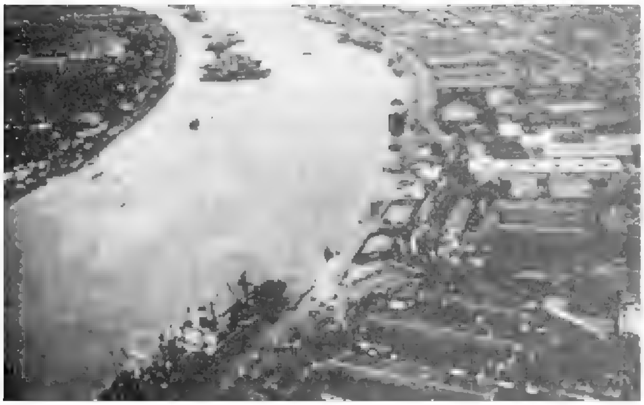
Distribution

Many of the problems that plagued the supply function in Vietnam also hindered the transportation or distribution function. High humidity and monsoon rains, coupled with inefficient warehousing, posed major problems (14:III, 4-14). Most items shipped to Vietnam required some type of packaging due to the unknown intransit and storage conditions at the offload points in Southeast Asia. However, the requirement was not always met due to economic factors. Another problem concerned the backlog of battle-damaged equipment that could not be packaged for shipment to the United States because of a lack of qualified specialists. To meet this problem, the Air Force Logistics Command organized special *rapid area transportation support (RATS)* teams to handle emergency workloads. RATS teams consisted of ten civilian specialists from air materiel areas sent to Vietnam on a temporary basis to aid in the packaging of damaged equipment. Because of the combat environment, military *combat logistics support squadrons* were formed, in addition to the RATS teams, to help for longer periods and in more specialized and hazardous areas. Both of these concepts helped to greatly reduce the cost of packaging items in Vietnam (14:II,I 4-15-18).

Another new and important concept of military logistics support in Vietnam was containerization (14:III, 4-19). In 1950, the US Army had developed a system called CONEX, a forerunner to containerization, to move supplies to overseas locations. In Vietnam, every major Army unit that moved to the theater carried its spare parts and supplies in CONEXs, and the total number of Air Force/Army CONEXs (150,000 units) provided 6 million square feet of covered storage (14:III, 4-20). Container ships permitted a shipper to containerize cargo at the depot for shipment to Southeast Asia via sealift.

In addition to containers, the Air Force had developed the *463L system* in 1957 to ensure efficient use of airlift capability and to reduce ground handling times. The heart of the system was the 463L pallet, a rigid platform that could be stacked with cargo to a predetermined height. Cargo could be palletized early and then quickly onloaded onto aircraft, particularly in combat areas.

Several distribution methods were used to move cargo to the Southeast Asia theater from the United States. Because the airlift mode was particularly overtaxed and needed for critical lift requirements, in 1965, the Joint Chiefs of Staff directed an expedited sealift called Sea Express. Using fast ships, Sea Express helped decrease the air cargo backlog in the United States by reducing the sailing time from the West Coast to Saigon to 20 days (14:III, 4-54). During the Vietnam conflict, sealift was responsible for 95 percent of the intertheater cargo movement to Southeast Asia.



Aerial view of Saigon port, 40 miles from the South China Sea. By 1969, port congestion had been largely relieved by the sharing of more effective management methods with Vietnamese stevedoring contractors.

The introduction of large, fast, long-range cargo airlift helped revolutionize logistics support in Southeast Asia. The C-141 and, later, the C-5 helped supply American forces in Vietnam quickly, airlifting critical supplies such as munitions and maintenance items. Because of the substantial congestion at West Coast aerial ports, the Military Airlift Command established inland ports to meet the need for rapid cargo delivery. Scheduled channel missions were also established from East Coast aerial ports to Vietnam, bypassing the West Coast ports and cutting down passenger and cargo intransit time. The long-range C-141 that was just entering the Air Force inventory in 1965 made these new ports and channel missions possible (14:III, 4-71-72).

Tactical airlift in Vietnam was responsible for repositioning thousands of troops to and from combat zones. Tons of ammunition and supplies were delivered by airland and airdrop methods to sustain isolated forces (6:11-12). Two locations in Vietnam were sustained by tactical airlift forces despite heavy and continuous enemy attack. At Khe Sanh in 1968, C-130 aircraft supplied 6,000 US Marines, who held off 20,000 Vietcong for more than 3 months (6:13). In 1972, tactical airlift forces supplied a Republic of Vietnam force of 20,000 men at An Loc entirely by airlift despite a sustained Communist attack (6:15).

The port systems in Vietnam were quite different from those in the United States. As previously stated, Vietnam had no modern transportation infrastructure, and the rapid buildup of US forces starting in 1965 failed to analyze important logistics limitations that were to cause difficult problems. The aerial ports had numerous limiting factors, the most serious of which were shortages of qualified personnel, lack of materiel-handling equipment (MHE), and inadequate facilities for handling passengers and cargo. The situation was aggravated by the fact that, between 1965 and 1968, the workload of Vietnamese aerial ports increased 1,200 percent (14:III, 4-85). Further, maintenance problems were encountered with the 463L MHE system. Because of the rugged Vietnamese terrain and inexperienced operators, equipment wore out much quicker than expected. The seriousness of special vehicles with a deadline for parts was not recognized early because the Pacific Air Forces (PACAF) had included the maintenance status of Vietnamese MHE in with all other types of vehicles (14:III, 4-97-98).

Water port operations were another serious logistics problem at the start of the war. There were shortages of deep-water piers, tugs, barges, and amphibious craft. Saigon was the only significant deep water port, and traffic congestion was great, with some ships having to wait for as long as 2 *months* to unload (14:III, 4-137). A crash program was begun for water port construction. Cam Ranh Bay was the largest water port construction undertaken. At a tremendous expense of time and money, the United States built up a port system in Vietnam.

Maintenance

Vehicle operations and maintenance proved to be another problem area in Vietnam. At the start of the war, there was no pool of vehicles in Vietnam to meet the immediate needs of the massive US buildup. To alleviate the immediate problems, the Air Force took vehicles from commands not directly involved in the war and sent them to Vietnam. Many vehicles had already logged more than 60,000 miles and did not stand up to the rough terrain. The initial assumption that the United States would keep forces in Vietnam only briefly led to a *service station* vehicle maintenance philosophy. In addition, the many different types of vehicles complicated parts and repair problems. These vehicles could have been replaced by only a few different types and still would have met combat mission requirements (14:III, 4-167-68).

Air Force aircraft maintenance procedures underwent changes to meet combat requirements. In the early phases of the war, the policy was to extend inspection and overhaul intervals. Aging and obsolete aircraft and equipment were used beyond their expected life cycles, and with greater use, these systems required more frequent maintenance at greater costs (13:III, 2-3).

Prior to the Vietnam buildup, the Air Force had instituted a *Clear Water* program to help reduce the gold flow problem in US currency. Tactical units were transferred back to the states from Europe and the Pacific, and rotational units were used to meet overseas commitments. These temporary duty units gave the Air Force greater flexibility operationally but at considerably higher cost in men, materiel, and support. A lesson learned in Southeast Asia was that a protracted, limited war cannot be fought effectively or economically on a rotational basis.

With the FOB concept initially used in Vietnam, tactical units deployed to their FOBs with only war-readiness spares kits and mobile aerospace ground equipment. The main operating bases did all maintenance that was beyond the capability of the forward operating base. The shuttle of aircraft between FOBs and MOBs for maintenance was time-consuming, and operational aircraft were lost for combat duty during this maintenance period (13:III, 2-40-50). As the buildup continued in Vietnam, maintenance capabilities had to be expanded considerably at the FOBs.

Prior to Vietnam, Air Force maintenance policy was to repair aircraft and equipment at the lowest possible level. Base self-sufficiency was the key world. This concept increased unit readiness, but it required more spare parts, facilities and support equipment, and people. This, however, was too costly a concept for Southeast Asia (13:III, 2-3). *Project Pacer Sort* tested the idea of forward versus rear area maintenance of reparables in a combat arena and influenced the change from the self-sufficiency concept of maintenance to the idea of optimum repair levels. No set formula was found to be the best for determining the optimum mix of forward versus rear area maintenance. A host of factors had to be considered in making such decisions, including the characteristics of weapon systems and the skill-level of mechanics (10:10-11). The most important lesson learned was that changing the basic support concept of a weapon system was not desirable *during* a war. Rather, changes should be made in peacetime and then used as planned in wartime (13:III, 2-25).

As previously discussed, Air Force maintenance squadrons had been, since the 1950s, organized in accordance with AFM 66-1, with centralized control under a chief of maintenance. In Southeast Asia, tactical units were organized in accordance with PACAF Regulation 66-12. The organizational maintenance squadron (OMS) was deleted and its functions assigned to a tactical flying squadron, along with munitions squadron load crews. The Tactical Air Command (TAC) had initiated a similar concept with a *TAC enhancement* program designed in 1966 to meet tactical mobility requirements. Maintenance and support personnel augmented the tactical squadron to give it an independent operating capability. Maintenance personnel included specialists for limited remove-and-replace maintenance (19:42-43).

Under the PACAF maintenance alignment, the OMS maintenance officer worked for the chief of maintenance but was administratively assigned to the tactical flying squadron. Two problems in particular arose with this alignment. First, the tactical squadrons performed the aircraft phase inspection, but the planning and scheduling of these functions, including the scheduling of maintenance personnel, was done by the chief of maintenance. Second, even though these maintenance personnel worked for the chief of maintenance, they were rated by the tactical squadron commander.

By the end of 1966, the maintenance organizations in PACAF had reverted to the AFM 66-1 structure. Because of the uniqueness of some diverse organizations, PACAF supplemented AFM 66-1, outlining policy and emphasizing the wing chief of maintenance as the overall manager of a total wing maintenance effort (13:III, 2-20-21). At the end of the Vietnam War, TAC also reverted to the organizational structure of AFM 66-1 as consolidation became the word and emphasis was placed on economy and reducing duplication of effort (19:43).

OV-10 intermediate maintenance in Southeast Asia.

Technicians preflight an AQM-34L (LORAN-equipped) drone. Launched from the wings of DC-130 control ships, drones provided otherwise unobtainable reconnaissance of the enemy's order of battle and disposition in Southeast Asia. To support this curious mix between an *aircraft* and a *missile,* maintenance crews were drawn from both ICBM and missile logistical backgrounds.

Because it was not possible to return all crashed and battle-damaged aircraft to the United States for repairs and in-theater contractor depot repair was saturated, *rapid area maintenance (RAM)* teams were dispatched to Southeast Asia. These teams consisted of civilian specialists that supported the depot repair effort by repairing aircraft in the field. RAM teams repaired in-theater 80 percent of the total aircraft possessed between 1965 to March 1968 (13:III 2-165-168).

Summary

The war in Vietnam brought tough new challenges to military logistics. A complete logistics infrastructure had to be supplied with equipment and personnel. Enormous problems existed in sea and aerial port facilities during the early part of the war. Climatic conditions in Southeast Asia presented new problems in packaging, storage, and maintenance of weapons systems and equipment. New long-range jet aircraft helped to speed the resupply mission of critical supply items from the United States while tactical airlift performed admirably in theater. American military logistics during Vietnam performed as no other logistics system had in any war, but the cost of waging war had been enormous in money, manpower, and materiel.

Post-Vietnam Strategies: Rubber on the Ramp

In the aftermath of Vietnam, the United States once again began to reduce the size of its military forces, both manpower and

In a war that seemed to scoff at the high-technology Air Force of the 1960s, the best answers were often low and slow designs such as the 1944-designed A-1 Skyraider.

equipment. With the termination of the war, military leaders could now turn to the process of revitalizing the country's military capability. The war had severely drained logistics reserves, and the immediate dilemma facing the military was the choice of quickly restoring current military forces to an acceptable level of logistics readiness or concentrating funds in research and development with the view of modernizing the US military force structure (5:13).

Faced with these two choices, the Air Force elected to modernize its force at the expense of supporting older systems. New weapon systems came online in the 1970s, including the F-15, F-16, A-10, and E-3A aircraft. With inflation soaring and costs of new weapons systems rising greatly, logistics support was often overlooked or postponed.

The idea of the day was to get these new systems to the operating commands as quickly as possible and worry about supportability and maintainability later. This strategy—to put *rubber on the ramp* as quickly as possible while accepting the risk of being caught short in spare parts and munitions—paid off in the form of a highly capable new force structure. Although the Air Force was often criticized for having inadequate spares for sustainability, the fortunate absence of major conflict allowed this window of vulnerability to pass free of logistical calamity.

Acquisition/Requirements

A New Acquisition Process

The acquisition of major defense weapon systems fell under the guidance of the new *Office of Management and Budget (OMB) Circular A-109.* Issued in 1976, Circular A-109 became the key document for development and acquisition of major systems for all federal agencies. It adopted procedures previously implemented by the Department of Defense in DoD Directive 5000.1, issued in 1971. Circular A-109 was further supplemented by policy guidance from the Deputy Secretary of Defense in 1981 in a paper called "Improving the Acquisition Process" (25:7); these policies came to be known as the *Carlucci Initiatives.*

OMB issued *Circular A-109* in response to findings of the Congressional Commission on Government Procurement meeting between 1968 and 1972. The commission identified several symptoms in the federal procurement process that reduced the effectiveness of acquiring major weapon systems (25:7). Among these symptoms were cost overruns, contested awards, defective systems, and false starts.

The commission pointed out that federal agencies were stating what they wanted in systems, rather than what they actually needed. There was frequently inadequate exploration of alternative systems and a lack of testing prior to quantity production. *OMB Circular A-109* attempted to resolve these problems by requiring federal agencies to define needs in terms of mission, first outlining specific deficiencies or capabilities (25:8). Priorities, risks and affordability were also to be analyzed early in the acquisition cycle.

The acquisition process (as of mid-1986) begins with identification of a mission need by a federal agency. Further mission area analysis identifies deficiencies in existing capabilities or opportunities for new capabilities in response to technologically feasible alternatives (25:9). After a new requirement is identified, the Service Staff (Army, Air Force, or Navy) prepares a justification of major system new start (JMSNS), which is later submitted to the Service Secretary. If the Service Secretary approves the JMSNS, it is then attached to the Service program objective memorandum (POM) for submission to the Secretary of Defense.

The Secretary of Defense approves new weapon acquisitions when he/she approves the Service POMs in the planning, programming, and budgeting system. The new system program then enters the concept exploration phase, which includes solicitation, evaluation, and competitive consideration of alternative systems (25:10). A program office is established, and alternative systems are evaluated to find the ones best meeting the mission need. These alternatives are then presented to the Secretary of Defense for a decision.

To aid the Secretary of Defense, the Defense Systems Acquisition Review Council reviews the program conceptual phase and recommends to the Secretary whether to continue or terminate a program. The Secretary's decision to continue a program leads to the demonstration and validation phase of the acquisition cycle (25:11), during which the number of alternative systems are reduced. Competition among systems is evaluated, and sometimes prototypes are built to demonstrate capability. Extensive testing and evaluation lead to the next phase of acquisition, full-scale development. The Secretary of Defense makes the decision for program go-ahead and approval to begin full-scale development and production of a weapon system. Normally, only the system that best meets the mission needs is continued in full-scale development. During this phase, procurement of long lead-time items required for final assembly of a system is initiated (25:12).

The production phase is the last phase in the acquisition cycle. It involves both production and deployment of a weapon

(Continued on page 162)

Shortages Delay Ranch Hand Operations—1966

Hostile fire was present over most targets, but Ranch Hand's increasing level of operations made fighter cover difficult to obtain during part of the period from September through November 1966. Lack of fighter escort caused cancellation of some missions, especially in III and IV Corps. In August, Ranch Hand received 3 new spray planes, and 4 more were added in September bringing the total number of UC-123s available to 14. Ranch Hand crews, eager to accomplish as much as possible with the new aircraft, occasionally tried to do too much. Clear weather in the area just south of the demilitarized zone (DMZ) in September 1966 allowed Ranch Hand to fly as many as four sorties per aircraft per day. Predictably, the herbicide supply ran low, and the planes fell below on their maintenance schedules. These circumstances forced the crews to stretch out their operations so that maintenance and supply could catch up.

William A. Buckingham, Jr
Operation Ranch Hand

Supply Discipline

Every solider of long service has his own collection of things that got snafued in the care, handling, safeguarding, and maintenance of property.

Here are three general comments:

- There is no substitute for troop duty in a company as the foundation for command and leadership at all levels—which includes a basic understanding of how to establish and maintain a supply discipline.
- A periodic inventory at long intervals is not enough; continued spot checks are required. Also, when property is discovered to be lost or damaged, over and beyond *fair wear and tear*, prompt administrative action is needed to ensure that persons responsible be made to account for it. In this way only can creeping shortages be prevented.
- The only way a commander can make certain his unit has good supply discipline is to play his part toward that end. He cannot, nor should he, try to do all the checking—he is the quarterback. His primary job is to call the signals, requiring others to carry the supply ball.

Major General Aubrey"Red" Newman
Follow Me

Widespread Corruption

Following the cease-fire, corruption became so intense that it prompted one senior embassy official to remark that it "now exceeds all known bounds—even by Asian standards." It seemed as though almost everyone who had the means to do so began to frantically feather his own nest, intent on protecting himself and his family from an uncertain future. It was an *Alice in Wonderland* approach. Those involved did not seem to understand or care that by misappropriating the materiel needed to fight the war they were undermining the very security they were trying to obtain, precipitating a situation in which their ill-gotten goods would avail them nothing.

An internal embassy report, warning of this condition and of official complacency in the face of it, stated:

> Corruption has been justified by the fact that salaries are too low for officials to make a living, that it has always been done, that it is a way of life in Asia, that all nations are corrupt—just in different ways, that it is just a form of preventionism and finally that any amount of corruption is better than communism.

The fate of the huge American base at Cam Ranh Bay serves to make the point that, following the 1973 cease-fire, corruption among South Vietnamese officials became incredibly intense.

In the February 1973 issue of *Army*, General Maxwell D. Taylor wrote, "When the war is over, much of the permanent construction, such as the great port at Cam Ranh, will be of inestimable value to the peacetime economy of Vietnam." But even such a distinguished soldier as General Taylor could not foresee what corruption would do to this once mighty facility. The ink was hardly dry on his article when the Saigon daily newspaper *Tien Tuyen* of 8 June 1973 reported that 27,000 sections of pierced-steel planking from the runway on the base had been torn up and sold on the open market.

This was followed by a full-scale investigation by the newspaper *Song Than*, which, in a 3-day series of articles 21-23 July 1973, accused South Vietnamese military commanders of massive theft of military supplies and equipment of all types from Cam Ranh. The newspaper charged that the base had been reduced to "a bare skeleton" following "savage despoilments by high-ranking officials who considered it as a kind of windfall in which it was stupid not to take advantage of as a golden opportunity to achieve wealth."

Song Than described in detail how:

> . . . waves and waves of air-conditioners, mountains of refrigerators, TV sets, fans, generators, fluorescent lights and thousands of other miscellaneous items have been stripped from the base by those whose business it is to make a fortune from the war.

Colonel Richard McMahon
"Saigon '75: The Inevitable Collapse," *The Retired Officer*, April 1985

Characterizing Vietnam Distribution

> The *push* distribution concept employed in Southeast Asia generated excesses and all the associated management problems indigenous with a bloated inventory (3:14).

The words from Magner and Bellizio's study *Materiel Deployment to Austere Locations* characterize the early distribution approach used in Vietnam. As one reviews literature concerning logistics support in Vietnam, it is important to remember several things. First of all, by 1965 when the big buildup began, the Air Force had been a separate service for more than 15 years and would play a significant role in this conflict. It had not participated as a separate service and to such a large degree in any previous war. Second, computers and automated information systems were introduced into the combat zone and interconnected the entire logistics support system. Although Air Force supply computers were not operational in Vietnam until the late 1960s, the inefficiencies and ineffectiveness of the earlier push distribution approach became much more visible when inventories were loaded into the computers and reported to logisticians and commanders at all levels throughout the world.

As the United States had initially distributed materiel in World War II and Korea, the principal logistics support for the buildup of forces in Vietnam was done under a large-scale push distribution approach called *Project Bitterwine*. Project Bitterwine push packages were shipped from sources of supply within the United States to Vietnam in 15-day increments. These packages were functionally designed; for example, all equipment and supplies needed to operate a base dining facility were in the Bitterwine food service push package. At first, the packages went directly to the combat unit; however, because these units lacked adequate storage facilities, subsequent shipments were stored in supporting depots. Problems developed similar to those in World War II and Korea concerning port congestion, lack of parts visibility, and the transporting of unneeded supplies, while mission essential items were lost or detained in the transportation system (5:IV, 1-6, 2:27).

Deputy commanders for materiel at several airbases in the Southeast Asia theater reported their personal observations concerning the success and/or failure of Project Bitterwine. They noted supply support problems as well as large quantities of excess property. A working paper for the Corona Harvest conference on USAF Logistics Activities in Support of Operations in Southeast Asia, 1 January 1965 to 31 March 1968, contained the following comments about Project Bitterwine and the lessons learned:

> The procedures *to push* supplies and equipment such as Bitterwine into a combat theater caused inaccurate supply records and excesses . . . . Because of the inability to properly account for receipts, additional requisitions were processed and duplicate shipments later received (5:IV, 1-5).

In 1970, the Congressional Committee of Government Operations published the report *Military Supply Systems: Lessons Learned from the Vietnam Experience*. They reported on the results of the push distribution system and the problems that evolved.

> As the shipping backlog grew, materiel was moved directly from ship to port areas to any available storage area and stacked at random. Documentation was lost or became illegible; location systems were ineffective; needed supplies were inaccessible, packaging became weathered and damaged and markings became illegible. Consequently because needed items could not be identified or located, they were re-requisitioned, further increasing the unending flow and compounding the problems (4:6).

In 1980, Lieutenant Colonel John T. Quirk analyzed Air Force logistics shortfalls of the Vietnam buildup of 1965-1968 as indicators of shortfalls in future conflicts (6). His detailed study examined 596 historical events during the early years of Vietnam and described these events in terms of the interaction between *logistics processes, functions,* and *resource elements.* Examples of these 596 historical events are Event Number 222: "Peacetime facilities could not support an increased flow of airlift," and Event Number 259: "The present logistics system does not provide accurate identification of spare parts, which are required to support weapon systems assigned to base" (6:D27, D31). Quirk listed eight subelements under *processes*, including requirements determination, resource allocation and resource distribution. His *functions* included transportation, maintenance, supply, and so forth. (six functions in all). His *resources* element contained eight subelements, including equipment, mission-related supplies, command support, personnel, and facilities. In the two examples already discussed, he related process, function, and resource elements as follows (6:D27, D31):

Event	Process	Function	Resources
222	Resource Distribution	Transportation	Facilities
259	Resource Allocation	Supply	Procedural Information

Having defined all 596 events in terms of a particular process, function, and resource element, he concluded that certain processes, functions and resources appeared frequently. His study revealed the following significant occurrences concerning the frequency of subelements in the 596 logistics events (6:95):

Model Element	Subelement	Frequency	Percent of Total Cases
Process	Allocate Resources	150	25.17
	Distribute Resources	145	24.33
Function	Transportation	167	28.01
	Supply	156	26.17
	Maintenance	124	20.81
Resource	Equipment	104	17.45
	Personnel	96	16.11
	Supplies-Mission	88	14.77
	Procedure Information	88	14.77

Quirk also concludes:

> While this summary does not identify the interactions between the elements of process, function, and resource, there are useful inferences that can be drawn by the logistics strategic planner. Given that a buildup of Air Force logistics similar to Vietnam of 1965-68 is being planned, the planner would be well-advised to concentrate his efforts in the process area of *resource allocation* and *distribution*; in the functions of *transportation, supply*, and *maintenance,* and in the resource areas of equipment, personnel, *supplies-*

mission, and procedural information (emphasis added) (6:95).

Although most of the materiel was transported to Southeast Asia via sealift, airlift provided increasingly more priority, time-sensitive requirements to the combat forces. Early in the Vietnam conflict, sealift was processed through the Military Traffic Management and Terminal Service (MTMTS), which coordinated shipments through the Military Sea Transportation Service. MTMTS coordinated airlift requests through aerial ports, which, in turn, coordinated lift with the Military Airlift Command (2:20). Technologically advanced transportation and communication systems provided the best distribution, and communication systems provided the best distribution resources the United States had ever enjoyed. Nevertheless, the United States continued to experience some problems as evidenced in the following comments:

> The lack of centralized traffic management in South Vietnam during the early stages of the war contributed to waste of transportation resources and created much confusion . . . port congestion, resulting partly from inadequate control procedures, but also from insufficient facilities. In 1965, there existed only two deep water ports in South Vietnam—Saigon and Cam Ranh Bay . . . . At the close of 1965, a backlog of approximately 164,200 measurement tons awaited discharge at the two ports (2:21).

However, new port construction and improved control procedures had virtually eliminated port congestion by 1967. Problems had also occurred with intratheater transportation, but streamlining control of intratheater sealift and airlift under the , at various locations within the Pacific theater, gradually improved in-theater movement of materiel (2:23).

> In May 1965, CINCPAC expanded the mission of the West Pac Transportation Office to include cognizance over intratheater sealift as well as airlift . . . a WTO branch was opened in Yokohama . . . . In November 1965, CINCPAC established another WTO branch office in Saigon to coordinate sealift and airlift problems with the MACV Traffic Management Agency. In March 1967 a WTO Movement Control Element was established in Thailand situated with the PACAF Airlift Control Center. Thus, the mission of the WTO evolved from managing airlift to control of all theater airlift and sealift resources and determination of movement priorities (2:23).

In addition to consolidating movement control, a *common supply system* was established in Vietnam to provide materiel common to all branches of the military under the direction of one of the Services. "Supplies covered by the system included Class I (subsistence), Class II E (general supplies), Class II F (clothing) and comprised about 3,500 items" (2:26). Therefore, the Army, Navy, and Air Force supported each other with this common supply system, thereby eliminating some duplication, which would have increased the distribution problems. Of course, because of different missions and weapon systems, much of the materiel (aircraft spares) remained *service peculiar* (2:26) and could not be managed under the common supply system. Another system that enabled the Services to expedite materiel to combat forces in Southeast Asia was the expedited supply procedures. Each services branch had its own system. "The Air Force system which enabled operating bases to requisition certain designated items, for example, aircraft, vehicles and generators from a single CONUS depots was called Speed Through Air Resupply (STAR)" (2:28).

In the last years of the Vietnam conflict, the Air Force gained better control over its logistics. The push approach was changed to a pull approach in which known requirements were requisitioned. A computer system (UNIVAC 1050-II), designed to control and account for inventories and/or requisitions, further improved the effectiveness and efficiency of the supply support.

Despite early distribution problems in Vietnam and some inefficiencies that existed throughout the war, the United States developed a successful distribution system to provide materiel to its forces through innovations and coordination of all service branches.

> The common supply system, the Service-expedited supply practices, and improved control procedures instituted by both COMUSMACV and CINCPAC all worked to ease the confusion in Vietnam. The logistical situation improved throughout 1966 and, by 1967, the logistics posture for all classes of supply in South Vietnam was fully responsive to the requirements of the operating forces (2:28).

Our distribution successes in Vietnam, not unlike World War II, can be partially attributed to the fact that our military forces were better equipped and more powerful than were enemy forces. Although US combat forces suffered from inefficiencies, excesses and even shortages of critical items, they had more materiel to prosecute individual battles than did the North Vietnamese. Therefore, the United States could *pick and choose* where, when, and with what it fought. Under these circumstances, it is difficult to exhaust materiel to the point that one cannot win the battle. As our potential adversary increases its arsenal, the United States will no longer be able to continue to fight as it chooses. All our materiel becomes vital to our effort to survive and win. Therefore, the capability of the United States to distribute that materiel to the expected contingency locations becomes increasingly more important.

Notes

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2. Joint Chiefs of Staff, Historical Division, *Movement Control in Three Wars: World War II, Korea, Vietnam*, Washington, DC: Joint Chiefs of Staff, March 1973.
3. Magner, Lt Col Stanley D., and Major Thomas W. Bettizio. *Materiel Deployments to Austere Locations*, AFLMC Report 781010-1, Gunter AFS, Alabama: Air Force Logistics Management Center, January 1982.
4. US Congress, House of Representatives, Committee on Government Operations, *Military Supply Systems: Lessons Learned from the Vietnam Experience*, 91st Congress, 2d Sess, Washington, DC: Government Printing Office, 1970.
5. US Department of the Air Force. *Working Papers for Corona Harvest on Logistics Activities in Support of Operations in Southeast Asia*, Part Three Logistics Subsystems, Chapter 1, Supply, August 1970, IV-1-5 – IV-1-9.
6. Quirk, Lt Col John T. "An Analysis of Air Force Logistics Shortfalls of the Vietnam Buildup of 1965-68 as an Indicator of Shortfalls in Future Conflicts." Research Report, Air War College, Air University, Maxwell AFB, Alabama, April 1980.

Major Gary F. Hollums
"Distribution Approaches: A History and a Suggestion," *Air Force Journal of Logistics*, Fall 1984

Vietminh Supply—1954

According to Bernard Fall, who wrote one of the best accounts of the battle, the Vietminh had assembled 49,500 combatants supported by 31,500 support personnel, largely coolies. In addition, Giap had 23,000 other troops along his main line of communication running north to the Chinese frontier. The French had about 13,200 men in the valley, of whom 7,000 were rated front-line combatants. Giap's forces thus enjoyed a superiority in manpower of five to one and immeasurably greater firepower.

Many authorities, Fall among them, believe the battle was won by the coolies who kept the supplies moving toward the front over 500 miles of jungle road. More than 20,000 coolies and local tribesmen rebuilt Route 41 leading to Dien Bien Phu and widened the turns so that the road would take artillery pieces and the 800 Soviet-built Molotova trucks. These and the thousands of coolies were the core of the Vietminh supply system.

Drew Middleton
Crossroads of Modern Warfare

Mobilization in Limited War

The force structure of the active duty components of the Armed Forces must be designed to permit adequate logistics support of ready forces in quick reaction to emergency situations. During peacetime, emphasis was in some cases placed on the maintenance of combat and combat support forces without adequate combat service support units and trained technical personnel. As a consequence, when contingency operations are undertaken and the Reserves are not called up, serious deficiencies in logistics units and trained logistics personnel may be expected. There is a need, therefore, to enhance readiness to respond promptly to limited war of scope comparable to the Vietnam conflict without reliance on national mobilization or call-up of Reserves to conduct logistics operations.

Lieutenant General Joseph M. Heiser, Jr
Logistics Support

Computers and the Battle

To guard against the possibility that one of the base supply computers might become inoperative through enemy action, natural disaster, or maintenance breakdown, we designed a mobile computer that could be quickly transported to replace a computer that was out of commission. We built it in three vans; it is air-transportable and can be hauled by rail or road. Completely self-sufficient, with its own powerplant and environmental controls, it can be in operation 6 hours after delivery. It has been deployed a number of times to replace computers that were temporarily out of commission or to precede the installation of a permanent computer, and each time it proved that the principle of a mobile replacement computer was sound.

The decision to put computers in the SEA bases has paid big dividends. Early in 1968, at the beginning of the Tet offensive, direct hits from mortar shells destroyed a supply warehouse at the Da Nang Air Base in Vietnam. Sixteen thousand line items of supply went up in smoke. Later that day, we assigned a special project code to the Da Nang base supply operation to guarantee top-priority replacement of those supplies. Asset records for the destroyed supplies were reduced to zero; consequently, the base computer automatically printed out stock replenishment requisitions, which were transmitted to CONUS depots that afternoon. Five days later, 78 percent of the requisitioned stock was in the supply-receiving line at Da Nang. Without the standard base supply computer, coupled with rapid communications and airlift of high-priority requirements, the prompt resupply of the destroyed items to Da Nang would not have been possible.

Major General Jonas L. Blank
"The Impact of Logistics Upon Strategy," *Air University Review*, March-April 1973

Retrospect: Choosing the Objective

It can be seen that the selection of objectives is not an easy task. Even the seemingly simple matter of "protecting access to vital raw materials" becomes complicated when applied to a specific situation. Yet, if we don't have the firm objectives, if we don't know where we are going, it is impossible to determine when we get there. That was one of the major problems of Vietnam, and it will continue to be a problem in the future if we do not determine precisely what we are attempting to achieve with the use of military force. In other words, we (and perhaps what is more important, the American people) need to have a definition of *victory*. This victory need not be a total destruction of the enemy or the complete conquest of his territory. It need only be the attainment of a political goal that prompted our involvement, such as the restoration of the status quo in the Korean War. It also should be recognized that in obtaining a decision on the precise definition of the objective, there is an inherent contradiction between military and its civilian leaders. For both domestic and international political purposes, the civilian leaders want maximum flexibility and maneuverability and are hesitant to fix on firm objectives. The military, on the other hand, need just such a firm objective as early as possible in order to plan and conduct military operations.

What we are faced with is the obverse of the problem President Kennedy faced when he issued an order in 1961 directing the Joint Chiefs of Staff to be "more than military men." Just as the military needs to be aware of political, economic, and social issues, so our civilian leadership must be aware of the imperatives of military operations. They need to understand that national policy affects not only selection of the military objective but also the very way that war is conducted. As Clausewitz put it, the primacy of policy in war rests on the assumption that "policy knows the instrument it means to use. A certain grasp of military affairs is vital for those in charge of general policy."

Colonel Harry G. Summers, Jr
On Strategy

Logistics Lessons from the Vietnam Era

Air Force Project RAND

Predeployment Planning

The first lesson can be stated as follows: *combat organizations should be structured to minimize the difference in organization and operating procedures between a peacetime training mode and a deployed combat posture.*

As a result of deployments to Southeast Asia in the early days of force buildup, the Air Force recognized a weakness in the organizational structure of tactical fighter wings. This weakness became visible as individual squadrons deployed to the theater from CONUS bases that were built around an integrated wing organization. Two factors account for this training beddown posture in the Zone of the Interior (ZI). First, the deployment concept had envisioned only short-term commitments of squadron-size forces, the notion being that longer periods of deployment would involve total wings. The second factor seems to have been a matter of economics: a consolidated wing is cheaper to maintain than one with a long-term squadron deployment capability.

Even though the force buildup in Vietnam eventually took on this deployment-by-wing look, there was an interim period during which individual squadrons moved onto newly built or refurbished bases and had to operate for long periods of time in a new environment, cut off from the comfortable operating procedures familiar to them under the consolidated wing management structure. The unit's field and organizational maintenance and base supply elements, for instance, met for the first time with squadron operating forces as the pilots stepped from their aircraft at the theater operating base.

In order to identify these and other possible shortcomings, the Air Force Scientific Advisory Board was requested, in the latter part of 1964, to undertake a series of studies that would identify problems and propose solutions. The Tactical Air Capability Task Force was formed, one element of which was a logistics working group. In 1965, this group published a report embodying four major conclusions that support the statement of the lesson learned as it is phrased above. The report did not treat a major question that had to be answered: how much would all this restructuring cost? The study group admitted it did not know but contended that the conclusions were so fundamentally important, in the light of recent experience, that the Air Force should be prepared to face up to the budgetary implications.

The Air Force accordingly studied the problem and arrived at the next lesson learned. *The cost of structuring a force with significant independent squadron deployment capability would be substantial but not unacceptably so.*

This finding resulted from a study effort that Headquarters USAF directed TAC to undertake immediately after most conclusions of the Scientific Advisory Board's report had been accepted. The study became known as the long-term TAC Enhancement Study. It examined a broad range of possible tactical fighter wing organizational postures operating at different levels of combat activity and attempted to place a price on each. Figure 1 illustrates the magnitude of the expected increase in costs. The bulk of this increase is accounted for by the added people, field maintenance equipment, war reserve supply kits, motor vehicles, and mobile facilities required to support the breakup of a consolidated wing into the newly selected deployment posture.

The conclusions of this study met with mixed reactions in the Air Force because of unanswered questions, some of which still remain. The exact amount of deployment capability required is still being debated. There are questions of how to allocate resources most efficiently within these wings and, just as important, how to bring permanently deployed tactical fighter wing structures into alignment. These issues still require study to select the best solutions from a range of possible alternatives.

A third lesson we have identified demands considerably more investigation. *Really rapid deployment of sizable contingency forces can be accomplished better under some*

A munitions crew uses an MJ-1 bomb lift truck to mount munitions on an A-1E Skyraider on a steel airstrip in Southeast Asia.

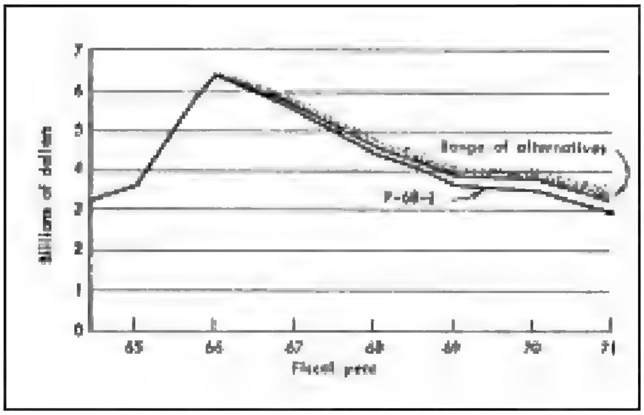

Figure 1: Estimated total obligational authority for the range of alternatives and the P-68-I General Purpose Forces Program (in $ billion)

different mix of prepositioning and transport, both surface and air, from that represented by our current capability.

This tentative conclusion derives from preliminary findings of a study now under way and from prior studies of the problem. Figure 2, taken from that study, represents eight different mixes of deployment capabilities that could be made available at equal cost and applied to only one potential trouble spot in the world. The difficulty lies in the number of options available to each of the several potential trouble areas. The answer to a dual question drives this problem. *How much force do we want to move, and how quickly must it arrive in the theater of operations?*

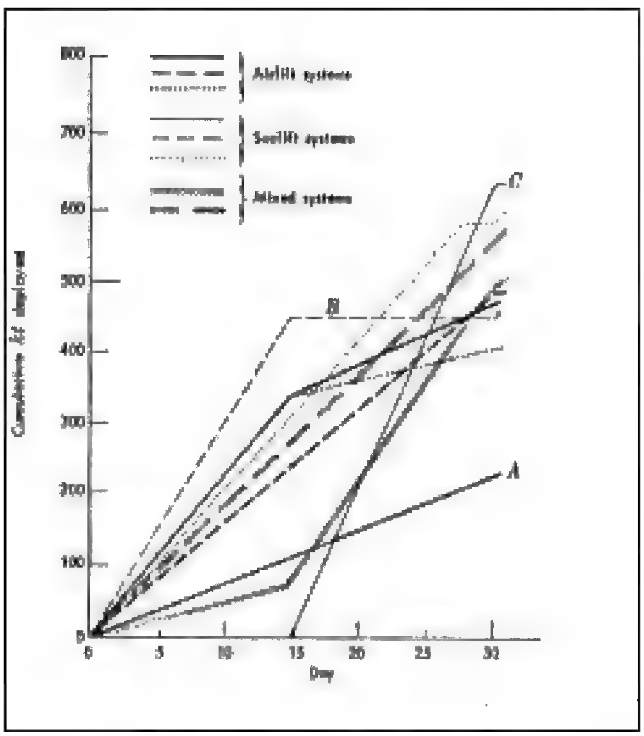

Figure 2: Alternative equal-cost systems: $10 billion, 10-year cost, deployment capability to one area

At one extreme, the planner is driven to large-scale prepositioning of heavy equipment, so as to use available transport for the rapid buildup of significant forces more efficiently. This extreme is represented by the *B* curve to the left in Figure 2. It assumes fast deployment logistics ships (FDLS), loaded and prepositioned in the vicinity, with a sizable fleet of heavy-lift helicopters and intratheater air transport moving cargo inland. At the other extreme, the uncertainty of long-term base rights near the potential trouble spots of the world makes the planner want his deployable support to be based in the security of US-owned property. For this security, he must pay a relatively high price as measured by the size of the force he can deploy within the time span that may be forced upon him.

This condition is represented by the *A* and *C* curves to the right of Figure 2, which represent total deployment of the force from the Zone of the Interior by air and sealift, respectively. All other lines are different equal-cost mixes.

It is not very helpful for the analyst to abandon the decision maker at this point, but for him to proceed further would require that he enter the arena of military judgment.

The present study raises but does not discuss an important corollary. *What range of options is available to us in the continuing support of contingency forces once they are deployed*? The question raises the obvious issue of the massive logistical problem posed by the heavy-tonnage items of fuel, ordnance, and subsistence. Also, the subtler task of building a logistics base on a foreign shore must be faced. Here the operational planner and the support planner must grapple with the question of how long the deployed force is expected to remain in the contingency area. Typically, initial stocks are intended to support deployed units for 30 days with no resupply. This statement does not furnish very valuable guidance to the support planner unless a great deal more information is added to it. Given that all is right in the deployment world, a realistic view is that, if any significant level of combat activity is to be sustained, a resupply system must be set in motion within hours after arrival in the theater. One segment of this resupply problem will be described. However, our discussion does no more than present some notions on improving resupply responsiveness to deployed forces after the buildup of whatever logistics base seems appropriate. The prior determination of this base is a problem that warrants close study by both operational and logistics planners.

One lesson emerging from the Vietnamese experience is outside the control of the military establishment but powerfully affects the military logistics structure. *The present operating structure of the Agency for International Development and similar agencies does not enable them to utilize the military logistics system efficiently; yet they must heavily depend on that system to accomplish their missions.*

In Vietnam, the United States deemed it necessary to engage in substantial nation-building programs both before and during hostilities; the same is likely to occur in future limited contingencies. These programs were so important in Vietnam that the cargo tonnage required to support them at times

equaled the tonnage needed to support the military. All of this tonnage had to move through the military logistics system; yet there was no counterpart civilian agency that understood the policies and procedures of the military establishment well enough to know how to enter and use the system. Both parties constantly had to resort to innovations and impromptu troubleshooting, which seriously delayed and confused our nation-building effort while degrading the military logistical capability.

This experience leads to the strong conclusion that governmental agencies engaged in activities of the AID type should create field staffs that can operate both at home and abroad. Their personnel should be trained to operate within the framework of the ongoing military logistics organization. A national priority system is mandatory for such joint use. We reached this conclusion while participating in a White House directed examination of the Vietnamese aid program during 1967. The results of this study are documented in a Bureau of the Budget report.

Support of Deployed Forces

During the entire term of the Vietnam action since 1965, the Air Force has engaged in a series of special tests using organizations committed to combat, with a view to answering a wide range of questions. One lesson emerging from these tests has important implications for those who are attempting to improve logistics management systems. *Many of the qualities needed in the normal logistics management system are contained in the special data-collection and analysis procedures used only for field test exercises.*

This lesson evolved slowly as RAND participated in six major field tests, spread over a number of years. The project names of interest are Sparrow Hawk, Skoshi Tiger, Rapid Roger, Pacer Sort, Combat Dragon, and Combat Sample. For now, it is important to say only that all of these were field exercises and, with one exception, were run in Southeast Asia, using combat units as the test organizations.

It had become apparent to the Air Force some years ago that the normal logistics management information system then being employed was not adequate to satisfy the needs of logistics managers. In the search for improvements, simple modifications were made to the database in the maintenance/operations interface area; these modifications increased its utility considerably at little or no cost. As experience was gained in the Air Force test exercises, the modifications were applied to the data-collection effort and then refined into what is now generally referred to as the RAND/TAC data-collection and analysis system. It was enlightening to observe how many of the modifications found necessary to the special test operations procedures were also required for improved normal management.

Remembering this, the Data Systems Design Office has tackled the much larger problem of attempting a major improvement in the total Air Force Base Maintenance Management System. It incorporates much that has been learned from field-test experience in capturing proper data; and it also addresses the problems of using those data effectively, not only for analysis but also for improved planning, scheduling, and control of ongoing base maintenance operations.

The Air Force project of interest is known by the acronym MMICS (maintenance management, information, and control system). This is a far more ambitious undertaking than merely transplanting some lessons learned from field testing. It is a major change in the character of Air Force base maintenance management. As such, it is beset by all the troubles associated with changing the management habits of any large organization.

Nonetheless, the simple lesson here is that logistics management procedures imposed by the military upon themselves when they undertake special field tests constitute one very promising area in which to seek improvements in normal management systems.

The next lesson can have a large impact upon the logistics systems of the military departments; recognition of it makes it a sensitive issue in force-size considerations. *There is evidence that some fraction of the military hardware in our inventory has considerably more inherent combat potential than is indicated by our planning factors for its employment.*

In the spring of 1966, the Air Force, for a number of reasons, decided to investigate the validity of a planning factor that had remained constant over a number of years in the activity rate it demanded of its tactical fighter inventory. This factor was sorties per aircraft possessed per day. As a planning factor, it drove a high percentage of the resources needed to operate the fleet. Crew ratios, fuel, and ammunition were directly computed from this number, and to a more uncertain degree, maintenance manpower, spare parts, shop equipment, and facilities were also affected. The question was, therefore, asked, "To what level can this number be driven for sustained combat operations; and what surge capability is then residual and for what period of time?" A corollary problem was the need to price each of these determined numbers.

Rapid Roger, an extended test of an F-4C squadron, was accordingly conducted in Southeast Asia in 1966. It ran from the summer of that year into the early part of 1967. The test showed conclusively that this weapon system, at least, could increase the output of the planned number of sorties by 50 percent and still have residual capability left for a short surge. When all data were later reduced and analyzed, it was discovered that the cost of operating at these higher levels was relatively modest in comparison with the inventory cost of the vehicle itself. A major portion of the cost increase of the augmented operations was derived from the additional air and weapon loading crews that would be needed.

Air Force analysts were quick to perceive the sensitivity of this lesson concerning the effect of increased sortie potential on the force size needed to perform a given job. An additional, broader study was needed to generalize this finding over other aircraft types and to address the important question of what happens when the mission requirement demands massed numbers of airframes as opposed to the generation of only some given number of sorties. This larger study was completed in early 1968 after an exhaustive examination with computer simulations of other aircraft and over a global range of

contingency scenarios. The conclusions are contained in an Air Force sortie rate analysis report. Their publication resulted in the previous planning factor being raised by 50 percent for the tactical fighter inventory of the future, subject only to the availability of the needed additional resources. The results of these studies may hold promising implications for other services.

A question plaguing the Air Force for many years is that of determining how much technical logistics support to place in the forward operating base. In the early Vietnam buildup, it appeared that the deployment of complete field maintenance capabilities to the operating base may have been unduly expensive in terms of direct maintenance manpower, shop equipment, and facilities. It was also postulated that the size of the indirect support was affected by this direct support element and might also be reduced. If either or both of these portions of the logistics tail could be significantly reduced, the complexity and cost of deployment and redeployment of combat units would be affected in an attractive direction.

Again, a test was planned and conducted in Southeast Asia to investigate the system implications of alternative maintenance concepts concerning base-level, versus depot-level, repair of aircraft spares. This exercise was named Pacer Sort (formerly Loggy Sort). The findings of this test provide us with our next lesson. *We do not yet know how to determine the best mix of operating-base versus depot-level logistics resources.*

This lesson cannot be said to result solely from Pacer Sort. The test reinforced previously held convictions that a host of factors impacting on this problem operates throughout our total logistics system. The nature of the factors is dictated by the fundamental characteristics of the weapon being supported. These are designed into the weapon by the manufacturer very early in the acquisition process and should greatly influence the maintenance concept and plans adopted for its support during its operating life; yet it is not clear they have done so judging from observation of those maintenance plans in operation.

The specific observations in this test dealt again with the F-4C. For instance, it was found that, even though special priorities were imposed on long-line communications and transpacific airlift to get good resupply response on a selected range of reparable components, there was no great reduction in the need for repair facilities, equipment, and manpower at the operating base. In analyzing the reasons, it was found, among many other things, that the characteristics of the F-4C were such that the base-level requirement for maintenance manpower, for instance, was dominated by flight-line demands. Of all base workload, 66 percent was generated at the aircraft itself, while only 34 percent was performed in the shops. Additionally, the skill level of the mechanic required at the aircraft was such that there was a high degree of transferability of that skill to the shop. It was not clear that the relatively high costs for the quick response from ZI depot to overseas base on reparable components for this aircraft were being offset by base savings, at least in maintenance manpower.

The obvious dilemma arises when a seven-level master sergeant who has to be there anyway to perform maintenance on the aircraft asks the question, "Why should we send this black box all the way back to Ogden and fly in a replacement when I can fix it right here in 2 hours with a couple of shop tools and a voltmeter?" Of course, he is not taking into account the cost and complexity of providing him with the few bits and pieces that his 2-hour job may also require or the cost and weight of the special shop environment he may need when he opens up that black box. Nevertheless, he has asked a fundamental question that logistics planners must not only consider but also resolve during the design process of a weapon system. His question also points up the undesirability of trying to generalize systems as we attempt to simplify tasks and reduce the logistics resources we place forward in support of combat units recalling that such units must deploy or redeploy in contingency operations.

The logistician needs an array of analytic and simulation tools that will provide him alternative system costs for a range of maintenance policies. They should be used at every step in a weapon system's development life, as well as in the search for improvements in weapons already in the inventory. Both RAND and the Air Force have grappled with this problem for some time A few bright spots are emerging. RAND has built a repair-level decision model, and Air Force initial reaction to it has been favorable. The model seems to be very useful for quickly examining the array of variables that must be handled in arriving at a rational maintenance concept for a weapon system. This model has been nicknamed SCAM (System Support Cost Analysis Model). As its name implies, it is certain to prove useful during preprovisioning actions. It is also hoped that further work will expand its value into the earlier stages of the weapon system acquisition process. In a parallel effort, the Air Force has under development an analytic model that addresses the life-cycle logistics implications of alternative designs in weapon systems. When fully developed, it will be another useful tool available to the logistics planner in the early stages of weapon system acquisition. In short, progress so far is limited but encouraging.

The final lesson derived from our studies of deployed forces appears as a reconfirmation of similar studies made in previous years. *Constant technological improvements in the speedup of long-line communications and of resupply vehicles continue to dramatize the inefficiencies of the management systems at the terminals within the system.*

This truth has been *discovered* so often during the last 20 years that it borders on the platitudinous. The reasons for its persistence are not far to seek. It has always seemed more rewarding to work on the clean-cut problems of speeding up long-line communications and increasing the velocity of the physical movement of cargo, while it is a vexation of spirit to try to secure noticeable improvements in that messy intertwined, management information system within the confines of the base and the depot and at intransit points.

The results of a recent RAND study indicate that the problem is still with us. For a 3-month period, three Air Force bases in the European theater were, in effect, fenced off for examination. These were a large base in Germany, a medium-sized one in England, and a small one in Turkey. The generation

Resupply Segment	Transportation Priority 1	2	3	4
Data Transmission	3.46	2.43	3.96	4.23
Depot Processing	2.24	3.57	11.05	12.41
Transportation	7.80	14.50	45.46	49.27
Total	**13.50**	**20.50**	**60.47**	**65.91**

Table 1. Response Times in Days by Transportation Priority: Off-the-Shelf Shipments, USAFE Sample Bases

of every demand for resources was closely monitored and traced through the system, and the arrival of resources at these bases was documented.

Table 1 presents a representative sample of the findings. A few observations about this table will clarify the picture. All requisitions from this sample, regardless of priority, were transmitted from the overseas base to the appropriate ZI depot via AUTODIN (Automatic Digital Network). The actual transmission time is measured in seconds; yet the time charged to data transmission is recorded in days. Similarly, all priority 1 and 2 shipments traveled to their destinations by air, both in the ZI and to the overseas break-bulk point. The time this cargo spent in actual movement to these destinations should be measured in hours rather than days

A European scenario was picked for this exercise so that the ad hoc innovations to the normal system that had been applied in the Pacific area would not bias the data. It was recognized, however, that the attention given to the Vietnam War might affect the so-called *normal* performance of the system in responding to European requests. Nothing in the data suggests that this latter force was operating to a noticeable degree in the test cases. Some resupply observations made while the previously described exercise task forces were in Southeast Asia indicate the resupply times to that theater, unless under the influence of some special *crash* priority system, closely resembled those shown here.

The problem is still with us then. And even though past efforts at both the base and the depot have made some headway, the problem of linking the central system with the field network of bases under deployed conditions still needs a focused effort. The Air Force is attacking part of this problem with a battery of studies under the heading *Mobility Support Forces Planning*. The Joint Logistics Review Board may find this area of investigation fruitful during the coming months.

As methods have been created for improving the management of individual functional responsibilities within the logistics process, it has become increasingly clear that all these functions need to be integrated, so as to yield a better balance in the utilization of logistics resources. Slow but solid progress has been made in forging useful managerial tools to address this problem. New stockage policy models enable more efficient placement of stocks across base-depot complexes. New forecasting techniques permit looking across functions in the computation of spares requirements. Finally, advances in data-processing technology, particularly in software, greatly enhance the utility of computers in serving the logistics manager's decision-making process.

With all these thoughts in mind, a broad final lesson can be stated. *An opportunity is now at hand for the Air Force to revise the materiel management scheme of its logistics system and more nearly optimize, across functional areas, the resources made available to it.*

Air Force acceptance of this conclusion and determination to do something about it have launched one of the most massive drives toward management modernization that any military logistics organization has yet undertaken. It is being conducted by the specially created Advanced Logistics System Center, a separate agency under the Air Force Logistics Command.

Its charter is to examine all elements of the Air Force logistics system, improve its materiel management capability by adopting advanced techniques and methods, and phase the new system in, making use of the latest data-processing technology.

A master plan for the task has been constructed, and the system specifications have been drafted. Detailed design is now under way, beset with the familiar difficulties of introducing major management system changes to a military department's established routines. The task of designing such a system may prove to be even more difficult and uncertain than the design of a major weapon system or command and control system and, ominously, may have to labor under inadequate funding. Military departments are eminently willing to allocate substantial budgets and create formal organizations for the design of weapon systems and command and control systems; it is not clear that the departments have realized the necessity of providing the same support for management system design efforts. To date, their efforts in this important area have been meager. The opportunity is here to make major strides in management system improvement, but there is serious doubt that the institutional machinery is adequate to exploit the opportunity.

Logistics Lessons from the Vietnam Era, RAND Report R-478 PR February 1970

Push Versus Pull: An Old Question Revisited

Movement control involved regulation of materiel flow based on total transportation capability and priority of multiservice need (1:10). Contingency situations almost always demand movement control, since decisions must be made about what goes first when requirements exceed transportation capability. This was highlighted during the US experience in Vietnam, when painfully developed systems of the 1965-1970 period arose from chaotic conditions.

The movement control system provides *the* vital link between shippers, the Defense Transportation System (DTS), and the user (3:145). Lack of it during the early Vietnam years caused port congestion at both ends of the transportation system resulting in delayed receipt of critical materiel by combat organizations (1:11). Although each military service had systems and procedures to manage cargo flow in coordination with transportation operating agencies (TOA), focus was strictly unilateral (3:32). Interservice relations became increasingly competitive as the battle for scarce transportation heightened. The joint perspective in modern warfare was overlooked, which often resulted in routine cargo of one service moving ahead of extremely urgent shipments of another, to the detriment of joint battlefield objectives.

This situation was (and would be today) complicated by the fact that transport assets could be called on in several different ways. No agency had an overall view of the state of the entire transport system and shipments moving within it. A brief treatment of this subject is warranted because it underlines the basic focus of this paper. That is, joint movement control at the unified command level is essential to ensure resupply supports the broadest military goals and objectives and that unified logistical decisions must link to practical operation of the DTS (2:163).

First, each Service and defense agency can separately forecast routine resupply/replacement movement requirements to TOAs directly (3:32). TOAs then program scheduled flights/voyages, with timing and type of capability tailored to meet forecasted demand. Second, each Service and defense agency can request to meet one-time or unanticipated requirements. These may be self-generated or by direction of higher authority. What normally transpires is since movement in the regularly scheduled system is most economical, the Services and defense agencies try to push as much unplanned traffic into the system as TOAs will accept. In a contingency, this quickly results in saturation and port backlogs, which the TOAs tolerate up to a point. Large port backlogs are useful since the greater the array of cargo awaiting movement, the better the airframe/vessel utilization and, therefore, productivity. This is qualified by the phrase *up to a point*, since after a certain backlog level is reached, management becomes quite taxing. Priority conflicts arise and shipper pressures grow due to the delays beyond normal movement timing parameters. The Department of Defense has provided TOAs with a simple transportation priority system for adjudication between competing shipments, but these priorities only reflect the urgency of need assigned by the organization *pulling* or *pushing* the shipment. There is no way to indicate one transport user's priority relative to other competitors for transportation and the unified command's combat objectives.

The bottom line in peacetime is when backlogs become unmanageable TOAs simply apply added capability to alleviate them. In a contingency, this will not work, because competing demands for deployment transportation, support for strategic weapons systems, and commitments to US forces in other forward locations all clamor for limited capability. To complicate things further, inter- and intratheater movement requirements vie for support from the same transportation assets and port-handling capability. Without a single agency responsible to monitor the dynamic capability-versus-requirements arena on behalf of the entire combat theater, the DTS can quickly become bogged down and, in terms of contingency resupply support needs, be inefficiently employed.

The Buildup

When the introduction of ground forces began in 1965, there was no overall control of movement flow, other than that exercised by the National Command Authority (NCA), in determining the exact mix of deploying forces. Each Service managed individual logistics support separately in accordance with defense policy (4:2 and 6). On-the-shelf plans were of little value since they were not related to the situation as it evolved (1:5). Even though a number of studies done early in 1965 predicted some of the coming difficulties, no corrective action was taken (1:5).

By late 1965, events had gone out of control, with primary emphasis on combat force deployment issues. The Joint Logistics Review Board (JLRB) Report states:

> Although the procedures of the Joint Chiefs of Staff for submission of movement requirements [by the Services] distinguished between those in support of routine requirements and those in support of contingency plans, they did not provide for a major military operation based on a series of incremental deployment decisions without implementation of an approved contingency plan (3:42).

In other words, force deployment decisions were ad hoc rather than controlled by a master plan. The JLRB report further states, "The deployment of US combat forces placed formidable demands on military logisticians" (1:4). These demands resulted from two conditions, which were:

> 1. US forces committed without sufficient lead-time for logistics preparation and planning.
>
> 2. Force package composition continually changed, dictating frequent adjustments to logistics support and leaving little opportunity for short- or long-range supply buildup (3:43).

At one point in the fall of 1965, 125 cargo vessels awaited berthing at ports that could only accommodate 25-30 ships at a time. Even more vessels were backed up in the Philippines

and Okinawa (5:D, 3). Symptoms of this sort persisted. For example, between July 1966 and June 1967, ship delay time awaiting offloading in South Vietnamese ports totaled 11,240 days (3:61).

The situation at CONUS ports was no better. As of mid-1966, the Military Traffic Management and Terminal Service reported 186,114 measurement tons of backlogged, unbooked cargo on the West Coast destined for South Vietnam (3:62). This was caused largely by imbalances between port capacity, port handling, and movement capability; it was further exacerbated by the poor interface among shippers and consignees (3:145).

In fact, much of the materiel being moved had little or no relation to actual resupply requirements. First, push-type supply systems were used that shipped materiel according to preplanned consumption rates, not actual use. Second, there was little or no supply discipline, resulting in duplicate requisitions, excessive quantities ordered and abuse of movement priority systems. Finally, plans, programs, and combat operations changed rapidly with little or no adjustment in supply (1:20).

Since the total transportation system was saturated, an increase in resupply cargo flow simply was not possible, even if additional air and sealift assets had been available or port-handling capability increased. This combination of a saturated transportation system, with neither additional lift resources nor port-handling capability available, finally forced the issue. By late 1966, a theater-wide movement control system had been pieced together and was gearing up.

Theater Movement Control Organization

Movement control began to take place, between May 1965 and August 1966, from the bottom up. At the beginning of the Vietnam conflict, CINCPAC's West Pac Transportation Office, Tachikawa Air Base, Japan, was the only minor agency performing a movement control function in the Pacific Theater. The WTO was created in 1961 to exercise CINPAC operational command of theater-assigned tactical airlift forces, consisting of five C-130 squadrons (6:5). Although flown by the Air Force, this fleet operated on a common user basis. That is, all services in the theater competed on an equal footing for capability with allocation determined by relative mission priority.

The WTO's role was expanded in May 1965 (6:11). Encountering increasing problems with determination of intratheater sealift priorities, the Commander, Military Sea Transportation Service, Far East, requested CINCPAC assistance. The WTO became the unified commander's agent for sealift allocation and movement priority arbitration with MSTS retaining command of sealift assets.

The next step in evolution of the movement control system came in September 1965 when COMUSMACV established a joint traffic management agency (TMA) for control of all transport activity in South Vietnam (6:11). This action was at least partially in response to the growing congestion at in-country sea and aerial ports. The TMA provided centralized, unified control of in-country transportation and was a single point-of-contact for out-of-country agencies.

There was further improvement in coordination and control of movement activity in November 1965. CINPAC directed establishment of a WTO Saigon branch with both airlift and sealift responsibility (6:14). It was a needed link between the TMA and the CINCPAC staff.

The next incremental development, perhaps the most significant one, occurred in January 1966, when CINCPAC formally chartered the Pacific Command Movements Priority Agency (PAMPA). This body was directed to:

> . . . insure that PACOM (Pacific Command)-bound sea and air cargo is most effectively moved in accordance with recipients' need for the material, the discharge and clearance capabilities of receiving terminals and the availability of sealift and airlift resources. Particular emphasis will be placed on the traffic for Vietnam (7:1).

PAMPA was located at Oakland Army Base, California, adjacent to both MSTS and MTMTS regional headquarters. Its initial efforts were crude, since control mechanisms were worked out as the new organization encountered problems. Once PAMPA gained credibility with service shipping activities and MACV (Military Airlift Command-Vietnam), it was able to effectively plan and control materiel flow to support both South Vietnam combat operations and other theater users. Since approximately 81 percent of all sealift and 74 percent of all airlift to Vietnam originated from the continental United States, establishment of the PAMPA as a filter for CONUS-originating movement was the single most important element of the movement control system's success (3:A-17, A-18, and A-25).

The final part of the PACOM movement control network was created in August 1966 with establishment of a theater Joint Transportation Board (JTB). The JTB was a policy-making body, charged with optimum utilization of all PACOM transportation resources in meeting CINCPAC's objectives (3:149). It also acted in an arbitration role, resolving differences that could not be settled between users and movement control agents. The JTB was composed of the CINCPAC Director of Logistics and service components senior logisticians.

Notes

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Major Gregory D. Stuffs
"Movement Control: Enhancing Contingency Resupply," Air Force Journal of Logistics, Summer 1983

Dien Bien Phu: On Sieges

A study of the various accounts leads to the conclusion that there were two main causes for the defeat.

The first was the insufficiency of French Air Force resources. Stewart Menaul draws a striking comparison between what the French were able to do at Dien Bien Phu and the American and South Vietnamese performance in the siege of Khe Sanh in 1968. In this action, two North Vietnamese divisions, numbering more than 20,000 men, besieged a garrison of 6,000. The siege lasted for 78 days. In that time, American Air Force and Navy pilots flew 24,000 sorties in which more than 95,000 tons of bombs were dropped. The defenders received more than 12,000 tons of supplies from 1,200 supply sorties. In Menaul's view, "The garrison held out entirely due to the right application of airpower in the right strength at the right time." Such an effort was well beyond French capabilities.

There is general agreement that the second major contribution to the French defeat was the persistent underestimate of Vietminh capabilities and an overestimate of their own. They could not believe the Vietminh could supply so large a force in such forbidding terrain; at the same time, they considered the terrain would not prove any serious impediment to their own sorties. The generals in Hanoi and Saigon were surprised by the weight of firepower the besiegers were able to bring on the fortress and by the virtual collapse of their own supply system in the last days of the battle.

Consequently, the greatest measure of blame must be assigned to the staff officers who planned the operation and then, when the situation began to deteriorate, failed to call a halt and to direct De Castries to cut his way out when he still had sufficient men and ammunition.

Did the Americans and other Allies learn anything from the siege? The American performance at Khe Sanh is part of the answer but only part. For the same underestimation of enemy capabilities and overestimation of our own contributed to the early American reverses in the Vietnam War.

One of the war's grim axioms is that no power ever learns from another's defeat.

Drew Middleton
Crossroads of Modern Warfare

Van Crevald on Vietnam Logistics

Another field in which centralization reigned supreme, helping create a huge demand for information that could not subsequently be satisfied, was the logistics system servicing the American forces in Vietnam. This was originally due to a deliberate decision. In his haste to get as many American combat units into the country within the shortest possible time, in 1965, Westmoreland took the risk of stripping away their organic logistics support. The relatively static nature of the war and cost-benefit considerations that favored the centralization and pooling of resources subsequently prevented that support from being restored. Supplies and maintenance were provided instead by specialized logistics command centers that gradually spread throughout South Vietnam and operated on a territorial basis.

The system was dependent on constant, detailed communications between the logistics command centers and the outfits in the field and, furthermore, on the former's ability to develop and maintain a statistical model of the latter's requirements, clearly an impossible task in view of the endless movements of units of many different types from one tactical area to another. The inability to forecast demand in turn increased the requirement for supplies still further, often making it necessary to requisition specific items from sources located on the far side of the Pacific.

As it turned out, the necessary amount of information simply could not be handled by the requisitioning system, computerized and unprecedentedly sophisticated though it might be. Instead of using information to fine tune the relationship between supply and demand, units were forced to send back men (the stationary logistics command centers, with no permanent ties to any single outfits, insisted that the field come to the rear instead of vice versa) to walk over acres of stores and depots as far away as Okinawa and pick up whatever was needed. When the necessary items were located, they often turned out to consist of equipment, which the headquarters in charge insisted it did not have.

In the future, wrote General Heiser of the 1st Logistics Command, it would be necessary to resort to a less centralized system and restore service units to their parent outfits, thus doing away with much of the requirement for information though at the expense of creating some slack resources.

Martin van Crevald
Command in War

Project Special Express: Munitions

The pipeline for munitions was based on maintaining a 30-day supply at the forward bases and a 120-day supply in the Philippines. It also took an average of 90 days to replenish the munitions depot at Clark and another 24 to 35 days to move the munitions to South Vietnam. As a result, a 7- to even 8-month supply of munitions was often tied up in the supply pipeline. It soon became apparent to both Air Force Logistics Command (AFLC) and PACAF that something would have to be done to expedite the flow of munitions to Southeast Asia.

In January 1965, Headquarters AFLC asked Headquarters Air Force to approve a plan that had been developed by AFLC and PACAF for accelerating the delivery of munitions to South Vietnam. In general, this plan called for five ships dedicated to moving munitions from the United States to South Vietnam. PACAF requested that the Special Express program be expanded to ten ships. AFLC dispatched a team to Southeast Asia to study the matter firsthand. This review and the Ogden AMA's analysis led AFLC to conclude that it could support PACAF's proposal for two separate Special Express systems with five ships assigned to each one. The expanded program would allow the Air Force to

maintain a 120-day supply of munitions in the general area of the forward bases, a 90-day supply on the ships, and a 30-day supply at the storage sites.

By the middle of March 1966, the Special Express program had been expanded to 15 (eventually 19) ships divided into three groups. The first—or Alpha—group consisted of six ships that stopped at Qui Nhon, Nha Trang, and Saigon. The second, Bravo, group also consisted of six ships, and its ports of call were Cam Ranh Bay, Da Nang, and Phan Rang. The third group, called Cocoa, consisted of three ships, which supported the Air Force's munitions requirements in Thailand.

AFLC did not use the Special Express system to support SAC's munitions requirements in Southeast Asia because SAC did not need the floating storage or selective discharge features of the system.

Logistics: An Illustrated History of AFLC and its Antecedents 1921-1981

Special Forces in Southeast Asia

Very few regular officers went to Special Forces (SF) before the days of its great popularity in the 1960s. There are various reasons for that. Career management advisors in Washington steered ambitious youngsters away and still do today. The entire concept and existence of Special Forces was so secret that few officers knew either of them or what they did. Most recruiting was word of mouth among friends. The noncoms would talk to those officers whom they thought would be good at the business; the handful of officers opted in by Bank also explained the situation to their friends and acquaintances. So Special Forces in the early days got a few castoffs and less than a normal percentage of quality career officers. It also got some freethinkers who had never adapted to the spit and polish of the peacetime, palace-guard, 82[d] Airborne Division. It got the innovators and imaginative people, who wanted to try something new and challenging, chafed at rigid discipline, and they didn't care what the career managers at the Pentagon said or believed. Many were reserve officers who had no notion of wearing stars and hence never designed their careers around the idea of getting certain vital *tickets punched*. An amazing number of those early Special Forces officers went on to a full 30-year career, serving in the final years as full colonels, not a few of them commanding one Special Forces group or another. They were an incredibly tough and competent little group of officers who knew how to fight and did so at the appropriate times. One of the early officers, *Blind Mike* Healy, retired in the grade of major general. Another, Dave Grange, was recently still serving as the three-star commanding general of Sixth Army. A sprinkling of regular officers began to request assignments but sometimes found they were not welcomed by the freewheeling reserves. Some left with a bad taste in their mouths, while a few found their niches and stayed.

Although outstanding officers are necessary for Special Forces excellence, the Army discourages repetitive SF tours for officers, with some justification. An officer needs a good, solid base of conventional operations in perspective. He needs it, too, in order to be accepted and respected by the other line and staff officers with whom he has to deal. Many of the reserve officers who chose to stay continuously with Special Forces hurt their careers. Many left the service after 20 years, and some merely crossed over to comparable jobs with the Central Intelligence Agency or AID.

Colonel Charles M. Simpson III, USA
Inside the Green Berets

Evacuation—Saigon Style

Air Force CH-53s and Marine Corps helicopters continued the evacuation of Saigon. Thousands of Vietnamese surged around the American Embassy. Gunfire from small arms peppered the choppers, but no one knew who was doing the shooting. Earlier in the afternoon, the American consul at Vung Tau, heading for the ships in the South China Sea in a commandeered boat, had been strafed by a South Vietnamese Air Force helicopter. The airborne command post, answering his plea for help, ordered an AC-130 gunship to *kill* the chopper. An electrical fire aboard the gunship forced it to break off the chase, but in the meantime, the boat made it to safety. The incident confirmed the fear of Americans during the last days of Saigon that the Army of the Republic of Vietnam, at least some of it, was trying to disrupt the evacuation.

At midnight, the weather and visibility remained good, so the evacuation continued. At 1:45 in the morning, the Joint Rescue Control Center reported that 6,619 people had been carried out. An hour later, the control center transmitted a Presidential order that only Americans were to be evacuated from that time on. This would include several hundred members of the Marine ground security force.

As the sun came up, there was panic among the thousands of Vietnamese swarming around the embassy walls. They climbed the barbed wire fence only to have US Marines force them back with rifle butts. America's withdrawal from Vietnam came down to a rush to the top floors of the Embassy. At 7:30 a.m., Marines slammed and barred the building's huge oak doors. One Marine shut off the elevators and then tossed tear gas grenades into the shaft. He then joined the others in a race up the stairs. At the fourth floor, they turned to throw tear gas grenades behind them. As they rushed the last steps to the rooftop helicopter pad, panic-gripped Vietnamese smashed through the doors below and surged through the gas into the Embassy up the stairwell. At the top of the stairs, the Marines threw more tear gas and smoke grenades down the well; then they ran out onto the pad barring the small door behind them. They climbed aboard Swift 22, a waiting Marine CH-53. The turbines whined, the rotor blades moved around, picking up speed with each revolution. The ramp came up, and the chopper lifted.

Major Earl H. Tilford, Jr
Search and Rescue in Southeast Asia, 1961-1975

Logistics in SEA: A Meaning for Today

Our years in Southeast Asia brought great spurts of logistical ingenuity, both in the field and back home. Today's Armed Forces are directly benefiting from the technological modernization and advances in logistical concepts.

In fact, in terms of support, it is hard to think of a time when lack of logistics supply really hampered our planning or employment. That, in itself, is an aberration. I recall reading a *Washington Times* column by newspaper writer Fred Reed entitled *US Forces Excel at Logistics*! He described watching the 82[d] Airborne parachute into a beet field after flying direct from the United States and doing so only 2 *minutes* off schedule. He further described the relative luxury in which we maintained ourselves, singling out how the troops dined in Da Nang on eggs flown in *that morning* from California.

Well, that is great. Or at least it would be great *if* you could hurt the bad guys by throwing fresh California eggs at them! If there is one thing that surfaces again and again to characterize our logistical effort in Southeast Asia, it is *lavishness*, aggravated by a lack of priorities and mammoth waste. Admiral Henry Eccles, long one of the US military's most respected logistics experts, called it a *soda fountain war*. Dean Jerry Peppers of the Air Force Institute of Technology called it our *air-conditioned war*.

These things are not said disrespectfully to the many who sweated and suffered in Southeast Asia. Rather, these characterizations refer to a *style of war*—a *logistical doctrine,* if you will—that violated important principles of economy, security, and objective.

Our level of investment was phenomenal considering the level of war waged. Secretary McNamara testified that, while the NVN force used *100 tons/day* of nonfood supplies, we were bringing in *1,350 tons/day in BX goods alone*. And the Army Chief of Logistics, General Joseph Heiser, has told us that only 20-30 percent of the US supplies in Vietnam were ever even cataloged. The rest was *lost or pilfered*. Good logistics is sustaining the needed level of combat at least at cost so that resources can be used elsewhere and so the home economy isn't bankrupted or inflated out of proportion.

I would suggest that it is very difficult to use Vietnam to show how *lack* of well-planned and synchronized logistical support hampers operations or impacts war efforts. But the reason for this was not that it *could* not have happened, particularly in view of the topsy-turvy priority system that made eggs and BX goods more closely watched than bombs and bullets. Rather, the reason logistics support didn't become a restraining factor was that we were *already pre-restrained politically.* We hardly ever got a chance to run out of anything or to pull off great logistical operations because we were repeatedly obliged to pull *back* before ever reaching that point.

I believe it is important to recognize this about the Vietnam conflict, because it is the only one most of today's force has direct experience with and the lack of logistics as a restraining factor causes us to *forget its historical and potential impact on war*. Our experience is Southeast Asia—where fresh eggs, personal stereos, and an *apparently* bottomless pit of munitions and fuel were all available at sprawling, secure bases under cover of nearly unchallenged air superiority—lulls us into the deadly error of assuming adequate and properly synchronized logistical support whether or not we have really looked to see if it is there.

Lieutenant Colonel David C. Rutenberg
Lecture, Air Command and Staff College, 1985

(Continued from page 138)

system and continues from the time a Service Secretary makes the decision to produce the system until the last system is delivered. Deployment involves support of a system, the training of personnel who will operate and maintain it, the demonstration of system performance, and the final delivery to the operating command (25:13).

The Air Force adopted the concept of *program management* for the acquisition of major weapon systems. Program managers are Air Force agents who manage the system acquisition process. They have the responsibility of tying together all the specialists and their different functions involved in the development of a weapon system.

During the acquisition process, the program manager "seeks to design, develop, and produce a weapon system that satisfies the need, meets the performance objectives, costs no more than predicted, and is delivered on or ahead of schedule" (23:52). However, performance of the weapon system often tends to be the primary consideration. The new system must meet the desired requirement. Tradeoffs must be thoroughly evaluated in terms of performance, schedule, and cost (23:57). But a fourth major factor, logistics supportability, was soon to become an equal partner and will be discussed shortly.

A major effort to streamline the DoD acquisition process was begun in the 1980s to reduce cost and shorten the acquisition time of weapon systems. To provide program stability and limit program stretch-outs that raise cost considerably, changes in systems were to be made only when requirements or development problems occurred. A major philosophy change in the design of weapon systems also occurred. The concept of *preplanned product improvement*, an evolutionary approach in system design, seeks to minimize technological risk by inserting provisions for advanced technology into a weapon system through planned upgrade of deployed subsystems (26:154-157).

Multiyear contracting was another new initiative to improve systems acquisition. Several advantages were expected over single year contracts. Unit costs would go down with improved economies of scale from production, industry would be willing to invest capital to improve production facilities and secure the latest technological benefits, and buys of a system could be stabilized with a set production schedule (2:2). In 1982, the Air Force used multiyear contracting for several programs, including the F-16 aircraft, Defense Support Satellites, and the AN/TRC-170 radio (2:2).

Acquisition and ILS

Throughout the entire system acquisition cycle, tremendous pressures were placed upon developing agencies to remain within cost and schedule projections. The frequent result was that systems were designed and produced with insufficient attention paid to how they were to be logistically supported once fielded. This problem led to the introduction of a benchmark concept known as *integrated logistics support (ILS)*.

The objective of ILS was to ensure that operating supportability and maintainability aspects of a weapon system would be considered in the design of a system equally with the technical performance, schedule, and initial cost. Since operating and support costs comprise almost 60 percent of a system's life-cycle costs, it is important to ensure that supportability and maintainability are built into a system during the design stage (27:41).

The Air Force Acquisition Logistics Division (AFALD) became the principal organization charged with ensuring that logistics factors would play an integral role in weapon systems acquisition (27:42). Since its inception in 1976, AFALD (later redesignated a center) has assigned *Deputy Program Managers for Logistics (DPML)* to work hand in hand with system program officers of the Air Force Systems Command to help provide supportable and maintainable weapon systems and equipment. Even with the DPML providing logistical assistance to the program manager, there remained the question of who was ultimately responsible for a system's supportability. With the program manager primarily concerned with the performance and cost of a system as the ultimate bottom line, logistics factors could still be bypassed.

To help alleviate this possibility, in 1982, the Air Force Chief of Staff directed that the Air Force Systems Command (AFSC) establish a Directorate of Acquisition Logistics, charged to assert AFSC logistics responsibilities (27:42). The Air Force Systems Command more closely interacted with the Air Force Logistics Command to ensure logistics factors would be delivered to operating commands "with a combat capability supported by 30 days of war reserves and a logistics support capability to maintain the operational system" (27:42).

Industrial Base

The success of the acquisition process at any given time depends largely on the technological and industrial capability of the American defense industry (24:74). As previously indicated, the tendency of the American industrial base after conflicts has been to reduce excess capacity no longer needed. To ensure a viable industrial base, the philosophy of executive branch of government driven obtaining military needs and equipment from the civilian economy when at all feasible.

The industrial base is composed of large prime contractors together with thousands of subcontractors. To ensure the plant capacity needed to meet wartime production requirements, the DoD *Industrial Preparedness Planning Program (IPPP)* was initiated in response to Presidential directive. The program was to develop, with industry, a plan to meet the production of selected equipment and supplies needed for wartime requirements (24:82). The IPPP, however, has generally failed to meet its objectives due to a lack of funding and the low priority afforded it by DoD (24:83).

Several factors contributed to a decline in the American defense industrial base. In the post-Vietnam period, defense expenditures in real dollars declined significantly, placing heavy burdens on contractors who relied primarily on defense programs for their business. Excess plant capacity, financial problems, and heavy debts were commonplace. Investments in new technology and equipment lagged as contractors sought to reduce the risk of financial losses in case the defense business climate declined further. With older plants and equipment, costs tended to be higher and productivity lower. Financial institutions were reluctant to lend to defense contractors because of the risks involved in the defense industry. Excessive government administration and required overhead to handle government data requirements tended to drive small contractors out of the defense business. As such subcontractors left the defense industry, prime contractors became more and more reliant on foreign sources for parts and subsystems (24:75-79).

Distribution

Improvements in military and domestic airlift capabilities continued in the post-Vietnam era. The C-141 aircraft fleet was *stretched* to allow cargo space for three additional 463L pallets, and an air-refueling receptacle was added for mission flexibility, reducing dependence on landing rights at foreign bases (20:43). The C-5A aircraft fleet was modified with a new wing to increase the expected aircraft service life by 30,000 hours and preserve our only aircraft with outsized cargo capability (4:14).

Along with the C-141 and C-5A aircraft improvements, the Air Force planned to procure additional C-5 and KC-10 aircraft to reduce the airlift shortfall. In addition, competition geared up as the Air Force announced plans to procure an advanced airlift aircraft with outsized capability to help alleviate intratheater airlift shortfalls (3:19). A CRAF enhancement program was designed to modify existing or new production commercial passenger aircraft to carry cargo during national emergencies. This effort was conceived to provide additional cargo capability without incurring costs of ownership.

In Operation Urgent Fury, the US deployment to Grenada, a new method of computerized aircraft load planning was introduced. The Deployable Mobility Execution System (DMES)—found on C-141, C-5, and C-130 aircraft—used a portable microcomputer to produce rapid load plans, thereby increasing airlift capability by 15 percent and reducing load planning delay by more than 90 percent. The DMES was typical of the many microcomputer applications being developed during the 1980s to ease the planning and tracking burdens of logisticians in all fields.

Several initiatives to improve sealift were programmed for the Navy in the 1970s:

1. *Sealift Readiness Program* was begun to help meet military requirements by calling upon commercial vessels for help. In return for MSC contracts, a commercial firm could be tasked to provide up to 50 percent of its vessels for military use in a contingency. One problem plaguing the program was that this concept took competition away from US commercial operations, while the government was liable for lost cargo opportunities (1:25).
2. R*eady Reserve Force* concept to meet surge capability was an option to improve sealift capability, but a lack of qualified crews and funding to remove ships from mothballs posed major problems (1:26).

3. Another concept was a *Build and Charter Program.* Private industry would build vessels and then lease them to MSC. This is a controversial method, since it would circumvent the congressional budget process (1:27).
4. A *Logistics Over-the-Shore (LOTS)* concept was developed for putting containerized cargo ashore in undeveloped port areas, but its practicality had yet to be proved in a combat environment (1:28).
5. A *Container Offloading and Transfer System* to support LOTS was envisioned with deck-mounted cranes to be added to container ships for emergencies. Cargo would be offloaded onto barges for movement to shore (1:28).

Other sealift logistics enhancements included two maritime prepositioning programs to store equipment and supplies aboard ships in the Indian Ocean. One program is the *near-term prepositioning force* (NTPF). Equipment and supplies for a brigade-sized Marine Air Ground Task Force (MAGTF) were prepositioned aboard 13 dry cargo and tanker ships chartered and controlled by the Military Sealift Command (4:13). These ships were placed in position near Diego Garcia and contained supplies, ammunition, fuel, and water for Army and Air Force units deploying as part of the rapid deployment force. A second program, the maritime prepositioning ship (MPS) program, would ultimately replace NTPF. The MPS program would preposition equipment and supplies for three brigade-sized MAGTFs (4:13).

Maintenance

After the Vietnam War, the emphasis on aircraft maintenance organizations shifted back to consolidation. Economy of operations was stressed, and new ways to improve the maintenance mission were sought. The Tactical Air Command, in an effort to provide more responsive support for its tactical mission, initiated a p*roduction oriented maintenance organization (POMO)*. The primary objectives of this new organization were to increase the effectiveness of maintenance, support the operational mission, and increase unit readiness (19:44). With the POMO concept, the maintenance organization was centered around three new maintenance squadrons: the aircraft generation squadron (AGS), the equipment maintenance squadron (EMS), and the component repair squadron (CRS). Repair resources were allocated to two functions, on-equipment and off-equipment repairs (19:45).

Under POMO, each maintenance squadron was assigned one of these specific functions. The AGS had assigned both generalists, who accomplished all on-aircraft maintenance, and specialists, who accomplished remove-and-repair maintenance. The CRS accomplished all off-aircraft equipment maintenance, and the EMS performed all ground equipment, corrosion control, and transient alert maintenance (19:45). The total maintenance organization remained centralized under a chief of maintenance.

The POMO concept, later designated the combat oriented maintenance organization (COMO), instituted two significant changes in maintenance philosophy. First, it signaled a return to the aircraft *generalist*. Specialists were cross-trained to accomplish other duties not directly related to their primary specialty. Second, the POMO concept was formally recognized in AFR 66-5, *Production Oriented Maintenance Organization*, as a second maintenance organizational structure, with major commands given the option of using either POMO or the standard AFR 66-1 maintenance organization (19:46).

Another maintenance concept that received significant emphasis in the mid-1970s was *Reliability Centered Maintenance (RCM)*. This concept had long been used by US commercial airlines, and the Department of Defense was sufficiently interested in the concept for the military. Under DoD maintenance policy, two basic tasks in aircraft maintenance were being accomplished, scheduled and nonscheduled maintenance. Scheduled maintenance was done at specific intervals to prevent deterioration of the inherent design levels of the equipment being inspected. Nonscheduled maintenance was a function of the scheduled maintenance program, normal aircraft operation, and condition-monitoring tasks. Its purpose was to restore equipment to its inherent level of reliability (8:10-11).

DoD interest in RCM stemmed from the need to improve materiel readiness and monetary savings in the aircraft maintenance area. Commercial airline maintenance practices seemed to be less expensive, but aircraft performance was just as good or better than with DoD practices. In the 1974 Planning and Programming Guidance Memorandum, the DoD issued its first formal guidance to the Services on the RCM concept. The Services were tasked to "implement for all new aircraft types entering operating service in fiscal year 1977 and beyond an engineered, reliability centered, maintenance strategy" (8:16-17).

The first military service to investigate reliability centered maintenance was the US Navy. Its Air Systems Command initiated a contract in 1972 with Lockheed Corporation to see if RCM could be adapted to the S-3A and P-3 aircraft. Tests conducted in 1973-1974 on these aircraft indicated that RCM seemed to reduce scheduled maintenance man-hours by 38 percent for a 6-month period and to increase aircraft availability by 192 days. Although the tests were somewhat confusing due to a lack of preimplementation data, the Navy adopted the RCM concept for its existing and future aircraft (8:19-20).

The Air Force had a program similar to the reliability centered maintenance concept in the early 1970s with the same objectives of reducing costs and increasing readiness. However, unlike RCM, the Air Force program did not have a structured and logical decision path for establishing maintenance tasks that were really necessary for aircraft reliability (8:21-23). The original Air Force initiative, begun in September 1974, was under a maintenance posture improvement program designed to reduce manpower and materiel costs and increase the effectiveness of mission support. In 1975, the Air Force contracted with the Boeing Company to develop a plan to evaluate the existing base-level scheduled maintenance and inspection program for the B-52 fleet. The Boeing study showed that, with a reliability centered

(Continued on page 160)

Logistics Enters the System Design and Acquisition Equation: Roots of ILS

Birth of ILS

On 19 June 1964, DoD Directive 4100.35, *Development of Integrated Logistics Support for Systems and Equipment*, was issued to ensure "effective logistics support for systems and equipment is systematically planned, acquired, and managed as an integrated whole to obtain maximum materiel readiness and optimum cost effectiveness." The directive was developed by the DoD Equipment Maintenance and Readiness Council, assisted by the Maintenance Advisory Committee of the National Security Industrial Association. This joint DoD-industry effort made the directive unique and demonstrated the universal concern for effective and economical support systems. Although this concern had long been voiced by logisticians, DoDD 4100.35 represented the first official move to improve the development of logistics support systems and, as such, was a milestone in defense system programming.

As with all new ideas, ILS was greeted with mixed emotions. DoD and the defense industry had been saturated with *integrated systems*, *systems engineering*, *cost-effectiveness*, *systems effectiveness*, and a seemingly endless list of new disciplines and management philosophies. There were many who felt—or hoped—that ILS would be just another buzzword that would soon be discarded. Others saw the need for such an approach to support planning but dreaded the inevitable deluge of new regulations, reports, and associated paperwork. ILS, however, did not go out of fashion or result in an unmanageable mountain of ink and paper. It wasn't long before the song of ILS was being sung from every professional circle within the defense community.

Early Forums

One of the first major forums for discussing integrated logistics support was the first Electronics Industries Association Conference on Systems Effectiveness in October 1965. C. W. Winkler of Douglas Aircraft presented a paper that highlighted the seven basic elements of the ILS concept as defined in DoDD 4100.35. Some of the key points were:

- ILS is necessary for the development of an effective and economical support system.
- For the most part, the cost of ownership of weapon systems far exceeds the development and investment costs.
- The cost of ownership of weapon systems is most effectively controlled by emphasis on ILS as early in the conceptual phase of the system as possible.
- ILS represents the start-to-finish life-cycle planning of total maintenance and logistics support of weapon systems.

The next several years saw a continuing interest in and further refinements of the ILS concept. At the First Annual Logistics Management Symposium, George J. Vecchietti of the National Aeronautics and Space Administration gave a firsthand view of the contract strategy then being used or being considered for use by NASA in the logistics support area. Award-fee contracts and early, meaningful pricing of logistics support line items were the two objectives NASA was pursuing to improve logistics support management. At the Second Systems Effectiveness Conference, Ben S. Blanchard of General Dynamics told of the interrelationship of cost-effectiveness, system effectiveness, and integrated logistics support. And at the Sixth Annual Reliability and Maintainability Conference, John E. Losee addressed the development of quantitative logistics performance parameters during the conceptual and contract definition phase of Air Force programs.

These men and countless others helped to better define ILS and develop procedures and methodology for implementing the concept. In those formative years, the defense community tried new and innovative management techniques in order to put ILS into the development process.

ILS Comes of Age

The first large-scale implementation of ILS involved the B-1 and F-15 programs. The B-1 ILS office was established within the program office as a directorate coequal with the other *standard* directorates such as engineering, test, and program control. The majority of the officers handpicked for the ILS team had engineering degrees and experience as maintenance officers or logistics officers. Responsibilities were assigned according to a three-dimensional matrix, with each officer given several responsibilities in three areas: logistics elements, subsystem design, and logistics tasks.

First regarded as just an Air Force Logistics Command liaison office, the ILSO was soon accepted as a working member of the B-1 team and was given program responsibility and authority for the acquisition of the support system. None of this could have happened, however, if the program manager had not recognized the importance of proper logistics planning and afforded ILS the same attention as was given to the other program functions. This same visibility was also afforded ILS in the F-15 program, where the ILSO had the full support of its program manager and was also manned by a select group of individuals with engineering support backgrounds.

AFALD Established

Such efforts to put ILS in practice were repeated in many other programs, both large and small. But the ILS effort was not restricted to program-level management. AFLC was continually assessing its role in system acquisition and saw a need for more active involvement. In April 1974, AFLC established the Deputy Chief of Staff for Acquisition Logistics responsible for focusing command management attention and resources on procedures, techniques, and activities needed to implement fully the ILS concept. Two years later, the Chief of Staff directed the establishment of the Air Force Acquisition Logistics Division. Operating as an AFLC subcommand, AFALD has the responsibility and authority to provide strong, constructive advocacy for controlling life-cycle costs and assist AFSC program managers during all phases of the system acquisition process.

Major Ned H. Criscimagna
"The Yesterday, Today and Tomorrow of Integrated Logistics Support," *DMJ*, October 1977

Reliability Comes of Age in the Air Force

In the late 1960s, the Air Force Logistics Command began to build a management information system to assess weapon system reliability—the *increased reliability of operational system* (IROS)—which has since been designated the D0-56 system. The purpose of IROS was to assimilate and array worldwide Air Force maintenance data. Through this data, *bad actors* could be identified, and management could focus attention on correcting the reliability of systems or subsystems that were preventing weapon systems from accomplishing their missions. In addition, IROS provided the needed tools to zero in on those systems or subsystems that should be replaced because of inordinately high life-cycle costs (LCC).

Early uses of IROS data justified large across-the-inventory modifications that proved very cost-effective. The initial programs selected included an ultra high-frequency (UHF) modernization program, a tactical air navigation (TACAN) modernization program, and an upgrade program for the APN-59B navigation weather radar used on cargo and tanker aircraft. Table 1 shows the dramatic results of these modification programs. The decrease in depot maintenance man-hours for just these three programs (394,000 man-hours per year) represents a cost savings of about $20 million each year. That, of course, is only a small part of the equation. Considerable maintenance man-hour savings were also accrued in the operational readiness commands, and more important, the operational readiness of the Air Force was significantly enhanced. Air Training Command provided an excellent example of the impact of the ARC-164 UHF radio modernization program. The T-37 aircraft, after being modified with the new radio, flew 2 years of training sorties before experiencing its first airborne abort because of UHF communications problems. By comparison, the older UHF radios usually caused several aborts each month.

The success of those three programs stimulated a continued expansion of the modification program to solve operational supportability problems. Very high-frequency (VHF) radios, inertial navigation platforms, doppler radars, high frequency (HF) radios, radar altimeters, VHF omnirange (VOR)/instrument landing systems (ILS), and transponders were added to the list of systems for upgrade through retrofit. The Air Force set its sights on high reliability for all common avionic systems; that is, those used on more than one aircraft. There is a success story associated with each of the programs. More important, there has been a significant increase in the availability of aircraft using these avionic systems to support the operational commitment.

In parallel to the efforts to identify avionics used on multiple aircraft, the Air Force started programs to upgrade many aircraft peculiar systems. The F-111D analog signal transfer unit was replaced with a digital signal transfer unit resulting in a mean time between failure (MTBF) increase from 46 to 217 hours and an annual cost decrease from $3.5 million to $100,000. Concurrently, the F-111D electronic converter set was replaced with an advanced microelectronic converter set resulting in an MTFB increase from 39 hours to an incredible 1,447 hours and an annual cost decrease from $1.2 million to $100,000. The major effect of these modifications, however, was an increase in the fully mission capable rate from 22.5 percent to 42 percent. For a modification cost of $40 million, the operational sorties available on a multibillion dollar investment had essentially doubled.

Technology's Visible Gain

The Air Force continues to pursue technological superiority in its weapon systems. Each new system adds new capabilities and new challenges for the logistics system. From the time sophisticated radars and bombing navigation systems were added to aircraft after World War II until the late 1960s, the added capabilities translated to reduced MTBF and thus reduced readiness. It was the introduction of integration circuits that finally caused MTBFs to increase. Table 2 shows the MTBF changes in fighter aircraft built over the last 25 years. Note that the low point was reached with the F-111s in the late 1960s. Since that time, the overall MTBFs have steadily increased, and the major contribution to that increase has come from the avionic equipment. Avionics built in the last 5 years account for only one aircraft failure in three, compared to two failures in three 10 to 15 years ago. (It is

	ARC-154 UNF Radio	ARN-118 TACAN	APN- WX Radar
Reliability of Systems Replaced (MTBF)	30-100 Hrs	100 Hrs	18 Hrs
Contracted Reliability (MTBF)	1,200 Hrs	800 Hrs	NA*
Depot Man-Hour Reductions (Yearly)	178,000-30,000	131,000-15,000	216,000 -86,000
Field Reliability Now (MTBF)	1,000 Hrs	1,075 Hrs	88-100 Hrs

*Only selected LRUs of the APN-59 were modified; therefore, no system reliability was contracted for.

Source: AFJL Program Managers

Table 1. Results of Modification Programs

Weapon System	*MTBF Total AC	MTBF Avionics	MTBF Nonavionics	% Failure Due to Avionics	% Failure Due to Nonavionics
F-111D	.690	1.112	1.773	.620	.379
F-111E	.860	2.176	1.422	.395	.684
F-111A	.897	1.593	2.053	.563	.436
F-105A	1.044	1.822	2.445	.573	.426
F-111F	1.098	1.997	2.439	.549	.450
F-4D	1.113	1.823	2.542	.610	.389
F-4E	1.158	1.782	3.307	.650	.349
F-4G	1.230	1.695	4.484	.725	.274
RF-4C	1.333	2.223	3.330	.599	.400
F-4C	1.375	2.821	2.615	.481	.518
F-16B	1.765	4.426	2.936	.398	.601
F-15CD	1.905	3.886	3.737	.490	.509
A-7D	2.119	4.218	4.258	.502	.497
F-15AB	2.299	5.497	3.952	.418	.581
F-16A	2.765	7.293	4.453	.379	.620

*Mean time between failure measured in flight hours.

Table 2. 1983 Aircraft Reliability Data

noteworthy that the older aircraft have been retrofitted with many of the across-the-inventory avionic modifications, which have increased their avionic MTBF substantially. The 1983 data in Table 2 reflects all common avionic upgrades incorporated into the older aircraft.) The Air Force and the Department of Defense are finally realizing the higher avionic MTBFs expected with the introduction of solid-state technology.

Systems Acquisition and Billion Dollar Retrofits

With all the gains being made through subsystem retrofits, the Air Force was still not realizing the large increases in total avionic reliability and availability that modern warfare requires. The obvious answer was to force industry to produce systems that could meet the rigorous requirements demanded of today's (and tomorrow's) battlefield without resorting to costly retrofits. Total avionic suites needed to be designed so upgrades could be done without totally reengineering the system. At the same time, the low rate of procurement of new weapon systems dictated greatly enhanced reliability and availability of selected older weapon systems. These systems also had to be designed to allow for future upgrades without again resorting to large retrofits.

Efforts began in the mid-1970s to develop standards that would accommodate the rapid acceleration of technology and minimize the costs of inserting that technology into weapon systems. These standards include a Multiplex Bus system (MIL-STD-1553B); a computer architecture (MIL-STD-1750A); a standard higher order language, Jovial J73 (MIL-STD01589B), soon to be replaced with ADA; a stores interface bus (MIL-STD-1760); and a standard automatic test equipment language (ATLAS). Form, fit, and function (F^3) specifications were also used for the first time. This allowed new and innovative technology to be rapidly assimilated without redesigning entire weapon systems.

These standards were developed with the joint participation of government, industry, and academia. Waiver procedures were established and the enforcement efforts started. The initial resistance, which always occurs when constraints are applied, has now subsided. The Air Force is now insisting on and industry is complying with standards that will allow orderly change in the future.

The problem of major upgrades to older weapon systems was addressed through two avenues—modifications to add capabilities and to make the weapon system better capable of accomplishing its designed mission. Two examples demonstrate the two modification approaches: the offensive avionic system on the B-52 and the avionic modernization program (AMP) on the F/FB-111.

	Current *MTBF	***Expected MTBF
Inertial Navigation Platform	5	786
Terrain-Following Radar	9	50
Attack Radar System	11	50
Signal Converter	15	383
Doppler Radar System	17	2,000
Displays	22	210
General Purpose Computer	47	750
Auxiliary Flight Reference System	48	Deleted
Radar Altimeter	72	2,000
Astro Compass	96	Deleted
**Combined MTBF	1.56	19.61

*Mean Time Between Failure Expressed in Flight Hours
**Mean Time Between Failure of All the Systems Listed Combined
***Comparison to Similarly Fielded Systems or by Contract Guarantee

Table 3. FB-111 Reliability

The OAS is a modification performed in conjunction with the addition of the air-launched cruise missile to the B-52. The vacuum tube technology of the 1950s is being replaced with the solid-state technology of the late 1970s and early 1980s. The change in technology over that 20-year timeframe resulted in far higher component reliability and single components (medium scale integrated circuits) that replaced tens and even hundreds of components of the 1950s vintage. Even though many new functions are being added by OAS, the resulting avionic reliability increase is dramatic; roughly 30 percent of B-52 avionic failures have been eliminated.

In contrast, the AMP was not designated to enhance the operational capability of the FB-111. The objective of the program was to replace obsolete subsystems with new technology subsystems performing like functions but with greatly enhanced reliability. The anticipated gains in reliability for the FB-111 are shown in Table 3. Assuming the anticipated MTBF is realized, the operational impact is an increase of 29 percent in weapons on targets. The operational impact of modifying the tactical F-111s is an anticipated 56 percent increase in target kills in the first 10 days of a war. All of this should be achieved while reducing the annual operating cost by more than $25 million.

Jerry D. Schmidt
"Avionics Reliability—The War We Are Winning," *Air Force Journal of Logistics*, Summer 1985

Mystique of the Air

An American without fighter aircraft seems equally incongruous. As skeptics from George Pershing to Tom Wolfe have inevitably learned, it is practically impossible to overestimate the cultural baggage Americans have tied to their fighter planes and pilots. Supersonic embodiments of the national fetish for high technology, they are as individualistic as the tank is corporate. And as such, they have thrived in an era of fiscal stringency leaving us with a variety of anomalies from a navy heavy on aircraft carriers and light on all other classes to A-10 ground attack aircraft, rather than advanced armored vehicles, to confront the Soviet tank threat.

Robert L. O'Connell
"Putting Weapons in Perspective," *Armed Forces and Society,* Vol 9, No. 3, Spring 1983

Is R&M Another Flash in the Plan?

The largest problem I see is getting people to acknowledge the "ultimatum" nature of Air Force R&M 2000. Many skeptics are pondering the question, "Why this time when many previous efforts floundered?"

The answer, in my mind, is very simple. We are saddled with a force structure and support infrastructure that we have inherited from the realities of a different era, one where sanctuary and an abundance of people were given. The world is not the same, and we must react to that reality now.

Brigadier General Robert P. McCoy

The initial logistical effort in air operations begins on the ground and calls upon the heavy equipment muscle of Air Force engineers.

Prime BEEF engineer teams create new airstrips and rapidly repair battle-damaged landing areas.

During the practical application of chemical warfare defense training during an annual Team Spirit exercise held in Korea, all jobs are performed wearing protective chemical gear.

A new C-5 Galaxy demonstrates a payload of 256,000 pounds—50 troops and their equipment and ground support.

(Continued from page 154)

maintenance program for the B-52 fleet, anticipated savings of 2,100 down days and almost 500,000 man-hours at base-level could be realized (8:25-28).

The results of the evaluation program of the B-52 fleet gave impetus to pursue an RCM program for the entire Air Force. The first step in this program was to evaluate all current aircraft fleet maintenance procedures and schedules to determine what RCM initiatives would be needed for each type of aircraft in the inventory. Because no such technical expertise existed in the Air Force, prime equipment manufacturers were selected to perform the analyses on individual aircraft. With this effort, the RCM concept was quickly absorbed into the Air Force maintenance program (8:36).

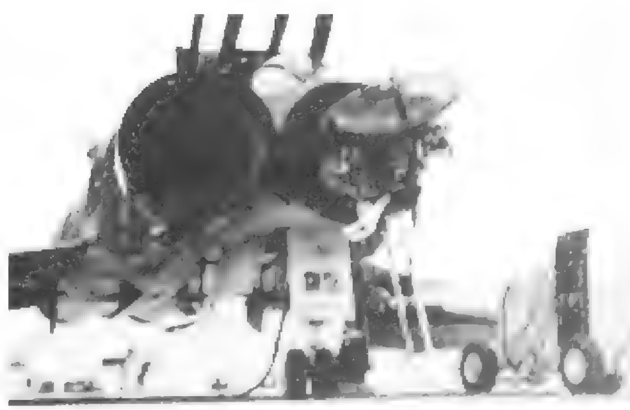
As the reliability centered maintenance program progressed in the Air Force and the other Services, problems surfaced that had not been considered in the early phases of the program. An Air Force Inspector General functional management inspection in 1978-1979 made several findings. First, no explicit guidelines had ever been given by the Secretary of Defense in defining the purpose of the RCM program. No stated objectives, no expected benefits, and no assessment of the benefits of RCM had been issued by the Defense Department. Second, the analysis of the RCM concept had not been consistent among the various weapon systems in the Air Force (8:53-54). An interservice/Office of the Secretary of Defense working group met in February 1979 to "determine the status of RCM in each Service and to delineate problems and areas of concern" (8:59). Of primary concern to the Services was the absence of a definition and principles outlining the objectives of RCM. Each service was using a different methodology in applying RCM to its maintenance programs (8:60). Another major problem was tracking costs and operational benefits derived from the RCM program. The working group tended to believe the potential benefits of reliability centered maintenance had been overstated (8:62).

Several studies to determine benefits of RCM had inherent problems. The major problem was the inability to identify factors that affected any potential indicator chosen to determine RCM benefits (8:79). Another problem was that existing data systems were not appropriate to assess tangible benefits of RCM. Despite these inabilities to define tangible benefits, by February 1981, the Air Force had completed the implementation or analysis of RCM for all aircraft and engines. Intangible benefits had been recognized as significant in improving the maintenance approach in the Air Force. Among these, RCM provided a:

1. Systematic and organized approach to what should be inspected.
2. Rigid method of analysis that justifies the selection of scheduled maintenance requirements.
3. System that complements the total Air Force maintenance program (8:80-81).

1,174 rounds of ammo are hydraulically loaded into the magazine of an A-10's 30-millimeter cannon.

Maintenance personnel check out an F-15, alongside Japan Air Self-Defense Force aircraft deployed for a Cope North exercise.



Crew chiefs prepare their F-15s for weapon system evaluation missions.

Logistics in NATO

The 1970s saw US logistics efforts in Europe aimed at increasing military readiness and responsiveness. In 1974, Congress directed the Department of Defense to improve the "commonality and standardization in weapons, equipment, and support systems in NATO" (North Atlantic Treaty Organization). Congress insisted that the Department of Defense "work within NATO to make standardization in research and development, procurement, and support an integral part of the NATO planning process" (9:7). One of these efforts resulted in a long-term defense program designed to develop new concepts of common planning, operations, and training for NATO allies. Allied tactical publications were developed to pursue common doctrine. Training was performed on a multinational basis, including a NATO logistics course and a NATO engineering course in the Federal Republic of Germany (9:10).

Perhaps the most significant progress toward standardization and interoperability was made in armaments. The Conference of National Armaments Directors was a leader in the development of a *family of weapons* concept for a more efficient division of effort in weapons development. Ongoing or pending cooperative programs included:

1. Dual production in the United States of the Roland Air Defense System, MAG-58 armor machinegun, 120- millimeter tank gun, CFM Engine for the KC-135 reengine, and the squad automatic weapon.
2. Dual production in Europe of the F-16 multinational jet fighter; MOD FLIR, M483, improved conventional Munitions; AIM 9L improved short-range air-to-air missile.
3. Cooperative programs in the multiple launch rocket systems, rolling airframe, and NATO small arms ammunition (9:10-11).

In other logistics programs of NATO, fuel was standardized for both land and sea forces. Air forces selected JP-8 jet fuel as the standard fuel for use in Europe (9:70). The Joint Chiefs of Staff identified the interoperability of ammunition as a high-priority goal for US forces, and the Army approved the *Army Ammunition Interoperability Plan* in 1979 to certify artillery, mortar, and tank gun ammunition for firing from American and Allied weapons.

The foremost objective in Europe was to deter a Soviet invasion (9:80). If deterrence failed, a coalition warfare would be needed to defeat the Soviets. During World War II, the Allies encountered problems in supporting each other with fuel and ammunition and were plagued by an inability to communicate rapidly and effectively. With NATO weapons and support equipment systems standardized or interoperable, field commanders would have increased flexibility, could reinforce units of one nationality with units of another, and could draw logistics support from the nearest source (9:81).

Plans for the defense of Europe were further complicated by the distances American forces would have to travel to get to the probable theater of battle. Despite forward deployed forces in Western Europe, the vast majority of American combat units were stationed in the United States. To reinforce NATO units quickly in case of a Soviet-Warsaw Pact invasion, these combat units would have to be deployed rapidly to the battlefield. With a critical shortage of airlift capability, the most efficient use of airlift resources would become paramount (3:16-17).

An Army concept of prepositioning, to speed up troop reinforcements to Europe, was begun in 1962, after the Berlin Wall crisis (7:31). Realizing that troops could not be sent to Europe quickly to influence the outcome of a European conflict if their equipment had to be sent simultaneously, the Army began stocking weapons and equipment to be maintained for ready-use. The *prepositioning of materiel configured in unit sets (POMCUS)* program was designed to preclude the necessity of using critical airlift resources to lift heavy equipment required in the early days of a European war. Under this concept, troops would be airlifted to a major base and then moved by host nation transport to a POMCUS site to marry up with their equipment. In approximately 8 hours, an Army battalion could be ready to meet combat requirements (7:31). By the early 1980s, POMCUS units could preposition up to 97.4 percent of their equipment in European storage sites (3:18). The key to success was adequate warning time before an invasion in Europe so combat troops could be airlifted to the theater.

Despite its advantages, POMCUS had several shortcomings. The most serious was its vulnerability to enemy forces. Equipment could be destroyed before troops arrived to use it. Another weakness was the lack of operational flexibility. Once a unit had prepositioned equipment in theater, its use elsewhere was virtually impossible (3:18). In addition, moving equipment from the European theater would leave the NATO alliance vulnerable to Soviet attack (7:33).

Despite these drawbacks, POMCUS reduced the movement requirements of Army combat units to the European theater. Other military services adopted similar methods of prepositioning war reserve materiel, munitions, petroleum, oil and lubricants in Europe to reduce early transportation requirements, particularly by air, and give units immediate combat capability (3:18).

Another method to improve American combat capability in Europe was the concept of *collocated operating bases* (COBs). These bases were established to serve as beddown locations for US forces deploying to Western Europe and would be made available in times of national crisis (3:19). Host nation support agreements provide facilities and support materiel to receive, service, and launch aircraft on combat missions on short notice (22:129). The COB concept was intended to lower the expenditure of millions of dollars on fixed installations and annual operating costs. Aircraft could be dispersed throughout the theater, and main operating bases would be relieved of congestion, enhancing combat capability and unit readiness. (At this writing, the ultimate extent of COB construction is uncertain, the outcome depending primarily on the availability of funding, both in the United States and in NATO).

Additionally, a new concept in theater airlift, modeled after the hub-and-spoke system popularized by many commercial carriers, was introduced in the European theater. The European

Distribution System (EDS) consists of dedicated logistics short-haul transport aircraft, forward stockage of spares, a control center and communications system, and automated administrative handling equipment. The ability to provide *same day delivery* of spares and engines is expected to significantly increase the daily availability of theater aircraft.

The mid-1980s also saw a resurgence of emphasis on *reliability and maintainability (R&M)*. A high degree of dependability, coupled with readily maintained and serviced aircraft unfettered by bulky test equipment, became necessary if the COB concept was to work. The quest for these kinds of systems also led to heavy emphasis on conducting meaningful research and development aimed specifically at solving logistics problems.

Another initiative to improve American capability to execute its defense policy in Europe was the NATO *Civil War Augmentation Program*. This program was designed to improve airlift shortfalls, with NATO nations contributing commercial airlift to assist in a reinforcement of Europe. At this writing, NATO countries had offered 49 aircraft to the Untied States for use during a European contingency (3:19).

Summary

The period after Vietnam brought many changes in logistics. Modernization of forces became a primary objective of the military, while logistics support for new systems was often deferred. New initiatives in the acquisition of major weapon systems were undertaken to reduce cost and improve supportability and reliability. The Integrated Logistics Support concept gained a firm hold on logistics practitioners. The American industrial base continued to decline as many subcontractors dropped out of the defense business. Major efforts were begun to improve NATO logistics in standardization and interoperability of weapon systems. Aircraft maintenance organizations were realigned to improve combat capabilities, and reliability centered maintenance became the new concept in maintenance by the end of the 1970s, buttressed by renewed commitment toward designing increased reliability and maintainability in aerospace weapon systems.

General Brown, Chief of Staff, on Maintenance Information Systems

An example of Brown's ability to cut waste is provided by Rogers:

> A new program introduced by the Air Force was an elaborate system of data keeping at the flight-line level, designed to measure the time and effort being spent by the mechanics on various types of activity, to improve maintenance through the use of statistics. The new system had been introduced at Williams shortly before I arrived and had already started to create problems, as new systems often do.
>
> The trouble was that nobody paid any attention to it. The master sergeant was the only one who seemed to know anything about it. The maintenance supervisors on the line and in the shops weren't enthusiastic and most of the mechanics were cheating on the figures. It looked like there ought to be something done about all this, because it represented a considerable investment in machinery, software, and time.
>
> It all began with a lot of punched card machines, and Williams was one of several bases that had been supplied with them. The equipment was presided over by a master sergeant from maintenance control. The system required that virtually all of the maintenance personnel on the base fill out what amounted to a time card each day. They were turned in every day, were processed and run through the equipment, and every day the machines produced an elaborate, impressive-looking *poop sheet*.
>
> The master sergeant and I came up with some simple bar charts that were easier to read than all that paper being disgorged by the computers. We were trying to make sense out of all this information. We then went up to see George Brown to get his reaction. We got the kind of reception from him that one would expect. He recognized immediately the validity of our trying to make sense out of it and utilize it.
>
> With that, we entered a new era in maintenance record keeping. George directed me to make sure that the people under our supervision who were providing the records from which the data were compiled fully understood their responsibilities, and that proved to be the key to the whole problem. With his backing, we were able to bring all supervisors together for on-the-job training and instruction. From then on we got full cooperation from the people providing the data, instead of lip service, because they understood that the data gathering served a useful purpose and was not just another piece of make-work. We began generating meaningful data of use to all commanders.

Edgar F. Puryear, Jr
Destined for Stars

The C-5A disgorging an Army Huey helicopter. (Air Force Art Collection painting by Doug Smith)

F-111 in combat colors enjoying a static road test after engine maintenance. (Air Force Art Collection painting, *Letting off Steam*, by Cal Sacks)

An A-10 marked as a Davis-Monthan bird is treated to a combat quick turn by technicians and loaders of the AGS. (Air Force Art Collection painting, *Surge*, by Marylee Moreland)

Friction and Complexity

Clausewitz's concept of friction describes why things naturally go wrong in war. Friction is bad weather during the Battle of the Bulge, contagious panic in France in 1940, an empty prison at Son Tay, and the dominant characteristic of the Iranian rescue mission. A famous response to friction is the WW II phase: "Keep it simple, stupid." Clausewitz considered friction to be the central factor that distinguished real war from theoretical analyses. The existence of friction means that war is not a deterministic process. The clarifying question concerning the impact of complexity on the man-machine relationship in combat is: *does increasing complexity increase or reduce friction*?

By necessity, we need to look at real war so this question can only be answered through historical research. Colonel John Boyd, USAF, Retired, significantly enriches Clausewitz's concept of friction in his *Patterns of Conflict.* This briefing summarizes Boyd's research on conflict from 400 BC to the present. According to Boyd, Clausewitz had a limited one-sided view of friction. Clausewitz was concerned about reducing his own friction (a valid concern), but he failed to see the *opportunities* for increasing his enemy's friction. Boyd observes that the writings of the Chinese military theorist Sun Tzu stress the opportunities and that the extraordinarily successful operations of Genghis Khan and Tamerlane exploited these opportunities. Boyd then synthesizes these two views with the operations of Genghis Khan, Napoleon, the successful German blitzkrieg commanders, and successful guerrilla commanders to a general theory of conflict—a theory that he *supports with historical analysis and observations from real war.* In sharp contrast to the deterministic view of the attrition mind-set, the central consideration in Boyd's theory is human behavior in conflict. In this context, he suggest that increasing complexity works on our mind and makes mental operations more difficult. It causes commanders and subordinates alike to be captured by their own internal dynamics; that is, they must devote increasing mental and physical energy to maintain internal harmony—and hence they have less energy to shape or adapt to rapidly changing external conditions. In Boyd's perspective, the idea of *decreasing* complexity to diminish our friction and free up our operations gives us the *opportunity* to magnify our enemy's friction and impede his operations.

Franklin C. Spinney
Defense Facts of Life

Firepower and Maneuver

In war, two great phenomena contend: maneuver and firepower. Maneuver is made of circumventing action to bypass the barrier, to outflank the thrust and evade the main strength of the enemy in all instances from weapon design to grand strategy. Such maneuver is the product of surprise, deception, and above all, agility in thought, planning, and action. And then there is firepower, which is measured by quantity, accuracy, and lethality; firepower is a product of industrial strength, transportation, and efficient logistics distribution. Throughout history, mixtures of maneuver and firepower have contended on a thousand battlefields. Maneuver has generally been the less costly course; but firepower has always been the surer course and has demanded merely an outright superiority in means. But even in the face of superior firepower and resources, maneuver in all its forms—tactical, operational, theater-strategic, and developmental, as well as the finest maneuver of grand strategy—has always done better than outright comparison of forces would reveal and often has prevailed.

But that was before maneuver finally met its match in the figure of the American *systems analyst.* When this new apparition came to take its place alongside the great captains of history, maneuver was finally undone. Its fatal defect is that no statistical index can be properly attached to surprise, deception, or agility; thus no criterion of effectiveness stated in numbers can be defined for the system analyst's computations. Firepower by contrast is easily quantifiable: volume being tonnage, accuracy being hit probability, and lethality being a known factor.

Edward N. Luttwak
"On the Need to Reform American Strategy" in
Planning US Security edited by Phillip S. Kronenberg

If there is one characteristic of modern Soviet warfare that has been particularly manifested on their battlefield, and which is probably emphasized more than anything else in current Soviet doctrine, it is surprise. It is my opinion that the Soviets—in the foreseeable future—will not attack in Europe without surprise and my opinion that they can achieve surprise . . . . I believe under the existing circumstances, a Warsaw Pact surprise attack will be successful, and that we will lose a war in Europe.

Colonel Trevor N. Dupuy

Technology Transfer and Military Supremacy

A host of other examples could be cited to document the full dimensions of the losses that the United States and its Allies are sustaining in the quiet war for technological supremacy. Military and industrial espionage have been the concomitants of international rivalry and conflict throughout the modern era. Yet the verdict can be ventured that at no previous time in history has one nation been able to prey so deeply and systematically upon the fruits of its adversaries' genius and labor. And probably at no previous time has an alliance of threatened societies been so lax in turning over the threatening power the technological wherewithal of their own security.

There is no ensured means of preventing the Soviet Union from obtaining advanced Western technology through espionage, although this administration has made a significant effort in such areas as tightening border security and increasing the awareness of law enforcement agencies and manufacturers of militarily relevant equipment. There is little hope also of substantially reducing the amount of technology the Soviet Union can acquire through open Western publications and academic exchanges. The potential penalties in infringements upon freedoms are too high.

Yet it is possible to control unwarranted legal sales. Here, the principal factor is the profit motive or, to put it more precisely, greed. It is essential that the Untied States and its Western Allies, through CoCom and other means, put a stop to the sale of military and dual-use technology to the Soviet Union and its allies and surrogates. A major effort is needed to persuade the US business community and the American public, as well as our allies, that the potential consequences of these transfers are intolerable.

Richard Perle
"Technology and the Quiet War," *Strategic Review*, Winter 1983

Military Needs

The US military needs sharp improvement in the reliability and maintainability of its weapons and technical systems. But the durable problems of weapons modernization and acquisition discussed earlier in these pages leave me profoundly skeptical about *buy now, fix later* methods. America's military, like any other military, must have upgrading and evolution of its equipment. But this is something quite apart from buying now what will not serve later or even long.

America's military needs careful study of authentic operational requirements in order to avoid the old problem of demanding performance levels that exceed requirements and hence result in degrading reliability. Further, in my opinion, the government must substantially enlarge its direct investment in military research and development. This is essential if only to regain necessary momentum in basic scientific and engineering research, the momentum requisite for keeping whatever technological edge the United States hopes to have. It has proven a thoroughgoing illusion to think the government could transfer the costs of research and development to the private sector. One way or another, directly or indirectly, the government pays those costs, if not in dollars then in inefficiencies, lost industrial capacity, declining numbers of defense contractors, diminishing competition, and correspondingly, diminished choices for defense officials.

In one sense, no major weapons program is a quick fix. It now takes 12 to 15 years to carry a new weapon from concept to initial operational capability and longer to complete a construction program on classes of ships such as Trident missile submarines, large numbers of tanks such as the XM-1, or aircraft or missiles. But it is possible to spend a great deal of money on major weapons without solving or even addressing fundamental questions as to whether or how they will make America's military better. It is this blind faith that buying weapons will indeed improve America's military and hence our national security that makes major weapons part of the quick-fix approach to military adequacy.

Thomas H. Etzold
Defense or Delusion? America's Military in the 1980s

High-Low Mixes

In another important response to the problems of reliability cost and numbers in advancing military technology, defense experts have argued the relative merits of what is called *high-mix* versus *low mix* investment. Simply put, proponents of a high mix, of continued investment in the most advanced technologies, point to the increasing sophistication of America's adversaries, to the possibility of falling into obsolescence, to uncertainties about likely future uses of American forces. They argue that only the most advanced technology will be adequate to deal with the most worrisome enemies and flexible enough to make American forces effective in the variety of political-military contexts the nation night face. Advocates of the low mix contend that the costs of advanced technologies make it impossible to buy necessary numbers of weapons and maintain them properly; that numbers matter; and that in places such as Europe where Soviet military power is greatest, the United States has no choice but to deploy more and cheaper planes and tanks even if they are individually less capable. There are also, as one might expect, advocates of a middle course, a high-low mix. It should be possible, they suggest, to analyze expected used of weapons to determine which of them require the ultimate in technological sophistication and, in contrast, which might be adequate even though less than the best.

High mix and low mix are, of course, relative terms. Nearly all weapons are very expensive indeed. But some cost enough

more than others to make a difference in basic choices about force size and composition. Consider a high-mix versus low-mix issue that has been at the heart of naval force planning for the last decade: whether to build a small number of large nuclear aircraft carriers, such as the *Nimitz,* carrying about 100 warplanes each, or a larger number of smaller aircraft carriers, possibly conventionally powered, carrying 40 to 60 aircraft each. The larger ones cost more than $2 billion apiece and with the cost of their aircraft and associated equipment, more than $4 billion each. The low-mix carrier's costs have been a matter of dispute, but usually they are estimated at between $1.2 and $1.6 billion, plus planes, for a total cost of about $3 billion or slightly more.

From issue to issue, each position—high mix, low mix, and high-low mix—has merit. But political uncertainties and analytic difficulties have prevented overall consensus within the military on high-low mix issues. From year to year, budget to budget, and administration to administration, the direction pursued in military modernization varies. Yet in general, with a few notable exceptions, the military leadership of recent years has tended to favor high-mix systems. Nonuniformed military experts in the Congressional Budget Office, in the Office of Management and the Budget, and on congressional staffs more often favor low mix or high-low mix compromises. Decisions on major weapons and systems thereafter reflect the prevailing bureaucratic and political balances and not their military merits, a fact that also contributes to long-term inconsistency in the character of American military forces.

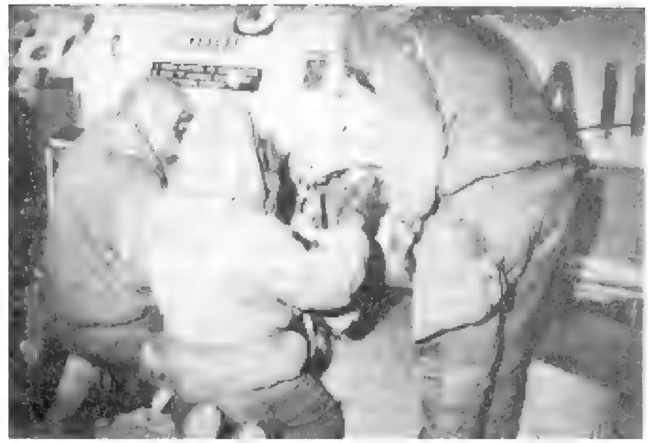
Thomas H. Etzold
Defense or Delusion? American's Military in the 1980s

A Strategy Psychosis

In the 1967 Middle East war, the Israelis took the Arab air forces out of action at the beginning of the war by attacking them on ground and destroying most of their aircraft. This happened to us at Pearl Harbor and in the Philippines during World War II while Hitler attempted to destroy the Royal Air Force by bombing their bases. Inexplicably, this principle of war has been essentially forgotten, because US forces operated with an almost inconsequential threat of attack against our airbases through most of World War II, Korea, and Vietnam.

Yet we are now confronted by a numerically superior enemy whose doctrine places foremost emphasis on surprise. He possesses airborne forces capable of seizing our forward aerial ports and armored and artillery forces whose expected rates of advance will place our forward airbases under heavy fire in the very early hours of attack. Most foreboding here, however, is that recent enhancements in Soviet tactical aviation (and especially development of long-range strike capability) make USAF overseas bases prime targets for preemptive strikes.

Colonel Harry L. Gregory, Jr
"Air Force Logistics Strategy for the 1900s," *Air Force Journal of Logistics*, Spring 1983



The 1980s brought renewed activity in two crucial logistical dimensions: quick repair of battle-damaged aircraft and continued operation and reconstitution after chemical attack. AFLC combat logistics support squadrons, assigned to each ALC, combined the two new critical elements during training exercises.

F-4 aircraft snarl in formation on the flight line in preparation for a Cope Thunder exercise. Held on Crow Valley range in the Republic of the Philippines several times annually, the exercises provided the opportunity for both air and ground crews to gain combat experience without getting shot at. The aircrews flew through simulated enemy defenses and in air-to-ground combat roles against F-5 *Aggressor* aircraft employing enemy tactics.

On War: Views of Logistics in the Eighties

The Yom Kippur War: Losses and Resupply

The exact number of aircraft lost by each side (in 2-1/2 weeks) cannot be accurately determined. Israel claimed that Arab forces lost 451 aircraft. According to Israeli sources, more than 370 Egyptian, Syrian, and Iraqi fighters; one Tu-16 bomber; and some 40 Arab helicopters fell to the guns and missiles of Israeli fighters in dogfights, for the loss of only 4 Israel fighters.

Major General Benjamin Peled, commander of the Israel Defense Force/Air Force during the war, states that altogether Israel lost 115 aircraft: 4 fighters in air combat, another one shot down accidentally by an Israeli fighter, 10 by accidents or unknown causes, 48 by surface-to-air missiles, and 52 by antiaircraft fire. Peled added that, overall, Israel lost one aircraft per 100 sorties, a figure that compared quite favorably with the loss rate in the Six-Day War of four per 100 sortie.

Altogether, Arab forces claimed to have shot down several hundred Israeli aircraft, most falling to ground-based air defenses. At a news conference on 21 October, Egyptian Major General Issad Din Mulhtar reported that, on the Sinai front, Israel lost 303 fighters and 25 helicopters.

US intelligence sources estimated that Arab missiles and antiaircraft artillery claimed 80 percent of the Israeli aircraft shot down, air combat 10 percent. According to the same sources, 242 Egyptian aircraft, 179 Syrian aircraft, and 21 Iraqi aircraft were destroyed by all causes.

While both sides suffered heavy losses, the Soviet Union and, later, the United States ferried in massive amounts of equipment. Soviet An-12 and An-22 transports flew 934 round trips to Egypt and Syria carrying missiles, ammunition, crated aircraft, and other materiel. In addition, an extensive sealift operation supplied an unknown quantity.

US Air Force C-5 and C-141 cargo transports flew 566 round trips to Israel, totaling 22,395 tons. Israeli El Al cargo aircraft carried an additional 5,500 tons, and an American sealift operation delivered an unknown amount. Israel received more than 80 A-4 Skyhawks, 48 F-4E Phantoms, a dozen C-130 transports, and a number of CH-53 transport helicopters.

In addition, the United States supplied such sophisticated weapons as Sidewinder infrared-guided air-to-air missiles, Shrike antiradiation missiles, Walleye glide bombs, Maverick television-sensor-guided air-to-ground antitank rockets, and TOW (tube-launched optically-guided weapon) short-range antitank missiles.

Lon O. Nordeen, Jr.
Air Warfare in the Missile Age

Shades of the 1980s: The United States and Iran

Commando operations are like all other infantry operations, only more so. They do, however, have their own rules, which the rescue attempt seems to have violated in every respect. The planners involved were, undoubtedly, good managers, economists, engineers, or whatever. But they must also have been quite ignorant of the military history of 40 years of British, German, French, and Israeli commando operations. Otherwise, they would not have sent such a small force into action. Here the rule is *a man's force for a boy's job.* Deep in enemy territory, under conditions of gross numerical inferiority, there must be a decisive superiority at the actual point of contact, since any opposition must be crushed before others can intervene to eventually subdue the commando force; there is no time for a fair fight.

If the planners had not been ignorant of the history of all military operations, let alone commando operations, they would not have had three coequal commanders on the spot and then a *task force* commander back in Egypt, not to speak of the Joint Chiefs, the Secretary of Defense, and the President—all connected by satellite. Here the rule is that there must be unity of command, under one man only, since in high-tempo commando operations, there is no time to consult anyway, while any attempt at remote control is bound to be suicidal given the necessary speed and secrecy of such missions.

If not for this ignorance, the planners would not have relied on a few inherently fragile helicopters. Here the rule is, since the combat risks are, by definition, very high, all technical risk must be avoided. If helicopters must be used, let there be 20 or 30 to carry the payload of 6.

If the planners had had any knowledge of these affairs, even of the one in which Americans had performed before, they would not have assembled a raid force drawn from different formations and even different services. Here the rule is that commando operations, being by definition exceptionally demanding of men and morale, must be carried out by cohesive units and not by ad hoc groups of specialists. That, indeed, is why standing units of commandos were established in the first place. If the suspicion is justified that the fatal accident was caused by a misunderstanding or worse between Marine helicopter pilots and Air Force C-130 pilots and that procedures, technical jargon, and so forth, are different, those involved carry a terrible responsibility. For there is much reason to believe all four Services were involved in the raid precisely because each wanted to ensure a share of any eventual glory for its own bureaucracy.

Edward N. Luttak
"On the Need to Reform American Strategy" in
Planning US Security edited by Philip S. Kronenberg

Falklands Logistics: America Pays Close Attention

But all of this—ASW operations, amphibious operations, and air operations—is overlaid throughout this campaign by the dominant role played by logistics. Operating 8,000 miles from home, bringing everything essentially *on their backs*, having only one en route base (one which was not designed for combat support of a fleet at sea), the British nevertheless succeeded mainly because their logistics system outmatched that of the Argentines at every point. When it became clear that one brigade was not going to be enough against a determined British effort, the Argentine logistics system could not cope with a need to supply a second brigade, *even though one was sent to the islands*. In contrast, the British accepted losses of planes and equipment in combat, endured heavy sea conditions, suffered predictable wear and tear and utilization rates of materiel, and yet were able to crank up and then sustain their logistics effort for as long as it took to do the job. Argentine weapons that worked did so with some devastating results. But British weapons worked more often. Maintenance, support, know-how, and morale, all played a major part in the ultimate British success. And controlling all of that was a command system that allowed the sort of rapid, flexible decision making needed to bring the right combination of forces to bear at the right place and time.

In conclusion, there are eight reasons why the British were successful in this case, and in large part, these will be keys to victory in any military endeavor. The first was the naval power they were able to bring to bear, allowing them political as well as military options. Second was their firm adherence to clear direct objectives. There was no *turning of the screws*, no incremental creep of what would constitute a satisfactory conclusion once military success became apparent. And toward that objective, there was going to be a political solution, or there was going to be a military solution, but whichever, it was going to be a clear solution. Third, there were clear orders given throughout from the political leadership to the military authorities. "Man and support the fleet. Send the force! Retake the Falkland Islands." Within these clear orders, the commander on the scene could plan and execute his operations. The fourth reason was speed—speed of political decisions once the need was clear, speed of military operations once the political order had been given, speed of execution once the military orders had been given. Fifth was mobility, both afloat and ashore. This provided flexible options, which allowed British strategy to continue to evolve as the operation progressed, taking always the best course, always the proper sequence. Logistics and training have already been mentioned but warrant mention again. Finally, there was the sheer willingness of the British to take risks. That is a necessary part of war.

Commander Kenneth R. McGruther, USN
"When Deterrence Fails: The Nasty Little War for the Falkland Islands," *Naval War College Review*, March-April 1983

An F-16 of the 310th Tactical Fighter Training Squadron, Luke AFB, Arizona, prepares to shut down for a postflight look-see by aircraft generation squadron mechanics. (Air Force Art Collection painting by Tom Morgan)

Chapter Six

Toward the 21st Century

The role of logistics in waging war evolved from the simple requirements of the American Revolutionary War soldier to the complicated and costly logistics requirements of today's modern warrior and machines. The United States, overall, continues to operate the best logistics system in the world, and with a worldwide commitment to the free world, the logistics community must remain ready to support a warfighting capability anywhere.

But what does the future hold? Will the United States and, in particular, the Air Force be able to sustain their combat forces in an all-out conventional or nuclear war against our foremost adversary, the Soviet Union and its client states? Will our logistics systems be able to survive and continue to support American combat forces in such a high-threat environment? Will our highly technology-dependent equipment be able to adapt to the wide spectrum of threats, from high-intensity European combat to low-intensity third world conflict, that may present themselves?

To support our future commitments, long-range planning for logistics is essential. In order to identify future challenges and ensure they are met, the Air Force initiated a *Logistics Long-Range Planning Guide*. This guide provides the direction and guidance for meeting the future logistics requirements of the Air Force and will be updated yearly. The *1985 Logistics Long-Range Planning Guide* gives five broad planning goals for developing a logistics posture characterized by mobility, flexibility, and survivability.

- Organize for wartime operations and conduct peacetime activities within that framework.
- Develop a logistics capability postured to support US forces engaged in varying levels of conflict, either independently or in concert with other friendly nations.
- Include logistics at the forefront of all Air Force contingency planning and weapon system design.
- Develop a means to better identify and assess logistics requirements and capabilities, especially those that relate to the execution of US contingency plans.
- Effectively manage or influence the management of high cost, critical, and scarce logistics resources to maintain Air Force combat capability.

Logisticians of today are being enjoined to emphasize American warfighting capability for the future. Management efficiency will continue to be important, but efficiency must be secondary to capability if logistics capacity is to match DoD planning objectives. Throughout history, warfare has been inherently inefficient (1:4). Our leaders and the American people must deal with the concept that peacetime requirements and processes must not degrade our warfighting capabilities (1:4).

In the future, the battlefield environment must be the critical factor in designing support concepts (1:5). To meet combat mission requirements, new methods and procedures must be found to reduce the logistics support *tail*. Technological advances in weapon systems and equipment will play key roles. Combat units at forward operating bases are being designed to perform primarily quick turnaround, on-equipment maintenance on aircraft. Off-equipment maintenance may be consolidated in a theater, and combat theaters will have to be more self-sufficient (3:202). Aircrews and logistics personnel must train in environments with limited capabilities to simulate combat conditions in an actual war.

Survival of logistics and operational forces may well be the key to winning a future conflict. Dispersal of assets to several operating locations may help ensure better survivability and sustainability of forces (1:5). Dedicated intratheater airlift and highly mobile ground transport will be required to support dispersed logistics operations (1:5). The future battlefield promises to be fluid and constantly changing, and logistical elements must be capable of changing with it.

American logistics in the future must adapt to a dynamic and ever-changing battlefield. Our American experience in the art and science of waging war must be analyzed and studied to better prepare planners and commanders for tomorrow's logistics environment. It is only through the study of history that the full impact of logistics on war can be appreciated and that we can avoid making the same logistical errors that have been fatal in the past. We ignore such lessons at our peril, for, in the words of Admiral Hyman Rickover, "Bitter experience in war has taught the maxim that the art of war is the art of the logistically feasible."

Airpower Theory and Practice

Except for the closing stages of the Second World War and in one or two isolated instances since then, the history of air warfare has been characterized by a divergence between theory and practice. Before the Second World War and in the early years of that war, it was a divergence caused very largely by a lack of resources but also by military conservatism on the one hand and by the inability of contemporary technology to close the gaps on the other. The imperatives of that war removed most of these obstacles, so that by its closing stages, all the claims that had been made for airpower by its advocates seemed to have been vindicated.

During the nuclear age that followed and with which this book has been concerned, the divergence of practice from theory has been of a quite different kind. The unbroken assumption of a military threat from the Soviet Union and her allies has meant that the resources with which to maintain airpower in the West have, on the whole, been available and to the extent that airpower has at times played a key part in nuclear deterrence and that no global war has taken place, theory and practice have run close together.

But partly because of an emphasis on that independent, strategic and, in a narrow sense, negative role, airpower has often been out of phase with the positive military demands that have been put upon it by the characteristics of wars that have been fought at very much lower levels. Theater conventional war in Korea, for example, found Western airpower equipped only for a limited strategic offensive, while the colonial wars saw airpower engaged in largely nugatory effort, because it was airpower that happened to be available rather than because it was a weapon appropriate to the tasks it was called upon to perform. But in wars where airpower was specifically prepared for the type of operations in which it took part—notably in the Arab-Israeli conflicts, eventually over North Vietnam, and to some extent in the Falklands campaign—airpower did have a decisive effect.

M. J. Armitage
R. A. Mason
Airpower in the Nuclear Age

Integrate Wartime Supply

The National Inventory Control Point (NICP) supply approach, in previous wars, has relied on the tried and true maxim of getting there "fustest with the mostest." Each of the functional elements within the NICP worked to acquire and then distribute to the theater as much property as possible. The typical pattern of NICP support for wartime units is known as the *push* system; that is, distributing in advance of known requirements those materials required to sustain forces. However, this system remains effective only when two logistics conditions are met: there must be an abundance of materiel and there must be ample time to acquire and move additional materials.

In World War II, the troops in each theater operated with an abundance of property. Although we were at war with Germany and Japan, we also operated with a time cushion. It took time for our enemies to mass troops and ships and to acquire the necessary supplies. Consistently, that cushion worked to our advantage in wartime supply. The North Africa campaign, for example, was delayed largely due to logistics problems. Stocks shipped to England to support this effort were lost in the large push of supplies from the United States. Duplicate shipments were required from stateside before the campaign could begin. We had the time to wait and the materiel to provide duplicate quantities. In Korea and Vietnam, we were able to control, for the most part, the timing and scope of the conflict. Supply problems could delay battles without serious problems. In all of these wars, the NICPs generated mountains of supplies and pushed them into the theater. Duplicate shipments were not uncommon and sometimes needed to ensure that the combat forces received essential supplies.

The two conditions under which we have operated so long have changed. Funding limitations over the last several years have reduced the available supplies and created a number of *critical spares*—classified as such because of the small numbers purchased. These funding limitations have also contributed to the decline of the industrial base by reducing the number of contracting instruments as well as the dollar size of the remaining contracts. The NICPs no longer have the assets available in great quantities and do not necessarily have the industrial base with which to generate a large number of assets quickly.

The time element has also changed. Where we once relied on sealift to fulfill all requirements, we are increasingly turning to airlift to meet many of our needs in the opening phases of a conflict. Rather than locate stocks at forward locations, we anticipate airlifting them into the theater quickly. This increases the immediacy of wartime supply and the necessity for the NICP to more correctly identify what stocks are required and where—and then to acquire and distribute those stocks.

These two conditions are intertwined, but collectively, they severely impact the way we have done business. With an abundance of materiel, we could locate stocks where we anticipated a conflict in sufficient quantities to give sealift time to respond. Without the abundance, we need a faster response time to theater requirements.

Captain Andrew J. Ogan
Lieutenant Colonel Joseph H. O'Neil
"Integrated Wartime Supply," *Air Force Journal of Logistics,* Summer 1982

Space: Logistics in a New Medium

Issue: Repair and Construction in Space

Consider what happens today to a satellite that fails in orbit. In most cases, we are limited to abandoning and replacing the lost vehicle. This is costly, especially if the satellite fails prematurely, fails to reach the proper orbit, or does not initially *turn on*. Although we use the shuttle to launch satellites, it has not been a dependable launching pad for satellites to *high earth* orbit. It has, however, been used effectively to retrieve and repair spacecraft. The retrieval capabilities of the shuttle were initially demonstrated on the Westar and Palapa satellites in early 1984. The 1984 retrieval and on-orbit repairs of the Solar Max Mission and Leasat satellites were the first significant US logistics maintenance actions in space. The return to service of the Solar Max and Leasat satellites saved us almost $300 million. We are now able to add the words *recoverable, reparable, and serviceable* to our space logistics lexicon. These are the events upon which we logisticians must build.

Some of the logistics events already demonstrated on orbit include transferring hydrazine fuel, capturing spinning satellites, erecting structures, and effecting various repairs. Many more such actions are planned. As technology and procedures are demonstrated in space, we can expect to eventually service satellites just as we do aircraft. Each will be scheduled for maintenance at specific intervals, whether on orbit or at space station repair facilities. Orbital replaceable units (ORU) can be developed similar to the way we use line replaceable units (LRUs) on aircraft. We can also use these service intervals for replacing/repairing instruments on board, incorporating equipment upgrades and modifications, or adding additional capabilities.

As the national space infrastructure grows, manned space activities will also expand. On-orbit assembly and construction of large space structure should begin in the 1990s, starting with the space station. The crew of NASA Shuttle Mission 61B recently demonstrated techniques for construction and assembly in space. The astronauts spent 12 hours in space building and tearing down a 45-foot truss tower and assembling and dismantling a large pyramid structure.

The question today is not *whether* but *how, when,* and *by whom* our space assets will be logistically supported. This should be determined during satellite design, during which many alternatives are considered and tradeoffs evaluated. Considerations should include the option of revisiting satellites in orbit. Some features might include provisions to allow for safe approach, grappling and holding the satellite, fluid and electrical interfaces, and built-in test. When considering whether to include these features in the design of a new system, costs (in both dollars and weight), paybacks, and tradeoffs must be examined.

Major Richard L. Bowman
"Space—The Logistics Challenge," *Air Force Journal of Logistics,* Spring 1986

Issue: The Strategic Defense Initiative

Lieutenant General James A. Abrahamson, Director of the SDI Organization, has maintained from the beginning that logistics and support will be critical for the SDI. Should it reach full-scale development, production, and deployment, an SDI system would have to be extremely capable. It would have to operate reliably over long periods of standby service in the demanding and hostile conditions of space, as well as in the equally demanding support scenarios typical of complex ground-based missile, radar, and support aircraft systems. General Abrahamson wants his research people to "think reliability, maintainability, and availability" for potential SDI systems because these bring with them the essential overall system capability. At the same time, though, logisticians must minimize the bureaucratic overhead that so often seems to accompany logistics.

It is helpful to refer to a February 1985 logistics strategy paper developed at an interservice logistics meeting on SDI at the Space Division (Los Angeles AFS). First, the group affirmed the need to establish a credible, productive logistics *presence* within the space technology, development, and management organizations responsible for SDI. Second, logisticians must position themselves to conduct analyses to *scope and define* support requirements, options, and associated risks for near-, mid- and far-term systems development and technology programs. Third, they must ensure application of logistics expertise to SDI *systems design* in concert with and based upon established or evolving operational concepts. Finally, they must aggressively advocate and pursue development of logistics *technologies* to improve SDI capability and affordability. These strategies formed the basis for the significant progress made during 1985 in establishing logistics integration on the SDI program.

On 15 October 1985, General Abrahamson signed the *SDI Supportability Research Policy*. This cornerstone document is the basis for ensuring that critical support capabilities will be available when needed. The policy provides first and foremost that supportability and logistics will be considered in an appropriate manner for a research program. Where logistics capabilities are available within the Services and existing support technologies can be seen as adequate even for the extensive demands of SDI scenarios, those elements can be carefully set aside with an understanding of the assumptions that permit such conclusions. On the other hand, some SDI-enabling technologies will almost certainly stress our ability to provide adequate maintenance, transportation, data, training, facilities, or other system support elements.

Colonel James L. Graham, Jr
Major Edward J. Tavares
"Supportability: A Strategic Defense Initiative Research Imperative," *Air Force Journal of Logistics*, Spring 1986

Understanding the Soviet Perspective

Ivan's Logistics: Hardware and Politics

In the Soviet perception, one must be careful not to confuse the political aspects of military power with the demands of actual conflict. Politics, economics, and military power come together at the level of *doctrine*, the highest conceptual level in the Soviet hierarchy of military thought. In the Soviet system, doctrinal consensus is embodied at the highest level before military strategy is formulated and military forces are planned. Military strategy and planning are, therefore, subordinate to military doctrine and theoretically subject to the broadest possible political and economic interpretations. This would put the Soviet military at the mercy of the whim of the politician and the economist, if it were not for the fact that there is a clearly prevalent and universal attitude that the success and even the survival of the Soviet Union depends on massive Soviet military power.

The Soviet view of war is thus a very *political* one, but it emanates from a simple and practical attitude toward military hardware. Political notions based on military power are not really the concern of the military man. In any case, such notions must flow from the ability to fight effectively. No Soviet military officer would be assigned *deterrence* as his primary mission. His task is to be able to fight and to win. Deterrence, if it flows from military capabilities and the broader political and economic context of international affairs, is the business of the political leadership.

Thus, the Soviets do not choose between deterrence and warfighting. Though Western discussion seems to suggest that the Soviets must accept one or the other, the Soviets understand both. War and military forces remain *instruments of politics* in the nuclear age in spite of the fact that the *scale* and *depth* of nuclear war have caused changes in the relationship between war and politics. But a keen eye is kept on the difference between theoretical concepts, the political effect of the *nonuse* of force, and the requirements for the actual conduct of war. The Soviets clearly have grasped the fact that the prospect of war in the nuclear age has political significance, but this has not permitted the peacetime configuration of Soviet military *posture* to become the plaything of academics and politicians.

These considerations do not apply only to nuclear weapons. There might well be a nuclear phase, and any major conflict and the use of nuclear weapons will probably be the decisive act in the war. Still, there is no Soviet tendency to make a fetish of nuclear weaponry. In the Soviet view, nuclear weapons are necessary but not necessarily sufficient. Conventional military forces must be adequate to ensure and consolidate final victory. On the Eurasian landmass, this means clear superiority over any potential opponent.

Steve F. Kime
Soviet Perceptions of War and Peace, edited by
Graham D. Vernon

Ivan's Logistics: Trends of the Eighties

The Soviet logistics system in recent years has concentrated on increasing self-sufficiency of combat units and subunits, speeding up and increasing the capacity of transport facilities, minimizing maintenance and repair problems by means of standardization, and improving efficiency of delivery to subunits through greater coordination of service and combat units.

Soviet production of military equipment has emphasized increased standardization of parts for easy repair and maintenance. For example, the PT-76 light tank chassis serves as the base for a variety of armored vehicles and missile carriers, and the T-54/55 tank chassis is used for bulldozers, bridge layers, and other vehicles. This concept also holds for small arms, such as variants of the AK model assault rifle. Small arms ammunition can be used in a variety of rifles and machineguns. Soviet arms production has always been evolutionary, with variations developed for older reliable weapons rather than throwing away old equipment in favor of completely new types. The Soviets rarely discard outdated equipment but stockpile it in strategic reserves. Standardization of parts means that many of these older weapons can be cannibalized for repair and maintenance using standardized parts and techniques.

Centralized planning is the core principle of Soviet logistical support. It is maintained at all levels by the chief of the rear to achieve economy and flexibility. The priorities for resupply are ammunition, POL, technical parts, and rations. These priorities are rigidly followed. The principle of forward distribution—that is, higher formations are responsible for delivery of supplies to lower formations using their organic transportation—is intended to free battalion and company commanders from logistics problems. In addition, large stocks of all types are held well forward. In particular, stocks of POL are held as far forward as possible so that formations can attack from the line of march with fuel tanks full. Soviet doctrine also calls for the maximum use of captured stocks, particularly POL, although the logistics in operations planning are unlikely to depend on this factor.

Soviet logistics do not constrain combat operations for units at divisional level and below, particularly during the initial phases of conventional combat. Transport capability is being improved at all echelons. At echelons above division, the increasing use of automated supply procedures and the introduction of materiel-handling equipment and palletization/containerization improve the Warsaw Pact's potential to conduct more sustained conventional combat operations. The Soviets have made and continue to make significant gains in alleviating shortcomings they have perceived in the logistics area.

William J. Lewis
The Warsaw Pact: Arms, Doctrine and Strategy

The Threat

War is a countrywide preoccupation in the Soviet Union. Historical experience, a domestic political system heavily dependent upon the perception of external threat, and nuclear age geopolitics combine to make the threat of war and the need for massive military forces persistent realities for the ordinary Soviet citizen. World war, even in the nuclear age, is thinkable. It is contemplated often.

They intend to be prepared in every possible way to place the brunt of battle, with or without weapons of mass destruction, on the adversary. But Russians have lived on past battlefields, and though they will do their best to avoid it, they probably live on one of the main battlefields of the next major war. For them it is the battlefield on which the victor, if there is to be a victor, will be determined. War will probably be a global affair, but victory and survival have a distinct Continental focus in the Russian mind.

The political implications of Soviet military power are understood and appreciated. New license for the projection of Soviet power and influence exists under the growing Soviet nuclear umbrella. This license is being carefully explored by a leadership mindful that security of the homeland must always enjoy top priority. There is also increasing latitude for productive political and economic accommodations with potential adversaries. This, in the Soviet view, is mostly because of Soviet military achievements.

But the *politics* of military power must never be allowed to interface with the *requirements* for potential conflicts. Forces must be built for fighting and winning. Political influence can only, in the Soviet view, flow from forces designed to carry the day in combat.

The Soviets' perception of war in the nuclear age by no means concentrates on nuclear weaponry to the detriment of conventional forces. Nuclear weapons may be decisive, but *all* types of forces and a militarized populace will be required for any hope of survival and victory. A vast panoply of military power, constantly modernized and disposed to secure Soviet territory from *outside* threats, enjoys broad support in the Soviet Union.

The Soviets do not want war. They cannot, however, fail to note that expansion of military power has been their primary claim to superpower status. No observer of Soviet domestic and foreign politics should expect Soviet military power to diminish, but neither should he expect the USSR to deliberately initiate a major war. The security of the USSR far outweighs the goals that any nuclear-age Marxist-Leninist is likely to pursue.

Still, Soviet attitudes toward the conduct of war are unsettling. There is a clear preference for the initiative and the establishment and maintenance of a crushing offensive that, even divorced from Soviet intent to use war for political ends, is frightening in the nuclear age. In the face of massive and growing Soviet military power at all levels of conflict and the probability that Soviet decision makers would have little appreciation of restraint once the conflict has begun, these preferences for the initiative and offensive are more salient than the judgment that the Soviets do not want war.

Steve F. Kime
Soviet Perceptions of War and Peacee, edited by
Graham D. Vernon

The Industrial Base: Circa 1985

This year the Air Force produced a document called the *Production Base Analysis*. Although it was not the first, it was the most extensive to date. It shows we are beginning to identify many of the deficiencies we have long neglected, although most solutions seem to be somewhere in the distant future. Essentially, the *Production Base Analysis* concluded that the ability to surge was "more coincidence than the result of purposeful direction." In the aggregate, our industrial ability to surge and sustain *whole* weapon systems remains suspect:

For large aircraft, we cannot surge the C-5 but can surge others; however, none can be sustained.
We can surge fighter/attack aircraft but cannot sustain them.
We can surge helicopters but cannot sustain them.
The same is true for aircraft engines: surge but not sustain.
Finally, tactical missiles cannot be surged or sustained without prestocked long lead-time pacing items, rolling inventory, and special test equipment.

This paints a grim picture, indeed, should we have to engage another superpower capable of attrition warfare.

Some of the other salient findings of the analysis applicable across the aerospace industry are:

- Weapon systems often outlive the technologies that support them. Yet the requirements for these technologies will increase dramatically in war, and industry may be unable to replicate *old* technologies due to fundamental structural changes in the manufacturing sector.
- Plants and facilities operate well below capacity, thereby making them vulnerable for consolidation and/or closure.
- Aerospace manufacturing is labor intensive, and the ability of the aerospace industry to increase its productive capacity may well depend on the capability to *train* an expanded labor force.
- A few large companies dominate the industrial base.
- At the prime contractor level, the government is the dominant customer.
- The subcontractor and vendor base has not been emphasized; concentration has been on the primes.
- Component lead times may dictate program schedules, as in the F-15 example.
- Critical skills may become a problem during surge or mobilization.

Lieutenant General Leo Marquez
"The Short War: Strategy for Defeat," *Air Force Journal of Logistics*, Winter 1986

Chapter Seven

The Logistics Constant Throughout the Ages

War often conjures pictures of combat and large armies moving to the field inspired by a clash of political ideologies or ambitions. Indeed, the intriguing twists and nuances of the strong political current sweeping every conflict forward or the intricate strategy and battlefield tactics that vie for positional dominance can hold one's attention to the exclusion of all other aspects of war. Yet the bulk of a commander's considerations involve the logistical limitations that drive changes to strategy and tactics in order to keep forces supplied and moving. All manner of logistical supplies are necessary to carry on military operations. However, fuel (fodder for animals or petroleum, oil, and lubricants) holds a special importance in that its supply has influenced and often dominated strategy as long as nations or states have fielded armies.

Transportation of supplies and materiel preceding modern day machines relied on some form of pack animal, principally horses. The horse's need for fodder dictated to the commander the terrain through which he could campaign as well as the campaign seasons.

Following World War I, new modes of warfare made the use of pack animals obsolete; however, armies still employed them on a much smaller scale to move supplies. Technology—manifested in aircraft and mechanized vehicles birthed in the First World War and nurtured during the interwar period—required a new type of fuel in the form of POL. During World War II, in the European theater, massive armies raced across battlefields, and mechanized equipment greatly increased the spectrum of strategic possibilities. However, commanders still had to account for logistical considerations that would influence their tactics. Increasingly, POL dominated their strategy and tactics. Further, POL products accounted for the majority of supplies shipped into theater during the war.

Regardless of its modern connotation, POL's intrinsic equivalent throughout history has been fodder.

Military Campaigns, Strategy, and the Need for Fodder

Most great commanders in ancient times, such as Alexander the Great, attempted to limit the number of horses on the campaign by ordering the troops and their attendants to carry many of their own supplies.[1] Yet, historian Donald Engels notes that pack animals were still necessary to carry "the army's noncomestible supplies, such as tents, hammocks, medical supplies, the ambulance, siege machinery, firewood, booty, and perhaps some of the women and children."[2] Though Alexander managed to significantly reduce the number of pack animals, Engels estimates that his army probably had about 6,000 cavalry horses and 1,300 baggage animals. Under the most favorable conditions, where the army campaigned in areas abundant in fodder and only needed to carry 1 day's supply of grain, they still needed approximately 1,100 pack animals to carry 269,000 pounds of grain, if each horse carried 250 pounds.[3] Engels notes that if an army traveled through an area devoid of fodder the number of pack animals needed to transport the grain and fodder requirements for 1 day would jump to 8,400 carrying approximately 1,260,000 pounds.[4] Noted historian Martin van Crevald, in *Supplying War*, similarly describes a generic premechanized army in which "the 40,000 animals accompanying an army would, therefore, require 800 acres per day."[5] Horses were imperative in a campaign, yet their subsistence greatly strained an army's resources.

Prior to the 18th century, few improvements were made to ease the fodder supply problem in Europe. In fact, the French made the problem worse by bringing extra men on the campaign to forage for fodder in the army's immediate vicinity. Historian John A. Lynn estimates between "4,000 and 10,000 men [were] necessary to mow forage for an army of 60,000"—each day a horse required approximately 24 pounds of dry fodder.[6] Interestingly, the French did maintain a magazine system to store troop provisions; however, the need to keep moving to find more fodder tended to cause the army to move too far and too fast away from this system of supply.[7] The ever present need to forage for more fodder forced the French Army to constantly move even when strategy dictated that it should not.

Strategy had to be adapted to account for horses' needs. Most historians agree the challenge of providing for the pack animals overshadowed the troops' provisions. Accordingly, the fodder requirement restricted an army's area of operations to regions that could sustain a high fodder intake. During the winter months when cold weather made fodder impossible to secure, armies were unable to campaign, and military operations necessarily became a seasonal activity.[8] Notably, in the 13th century, the Mongols possessed horses that could find food under the snow, so their timeframe for waging war was greatly increased.[9] Early conquerors bypassed cities and only occasionally conducted sieges, as fodder in the immediate area quickly ran out.[10] Intuitively, the massive effort required

to forage dictated strict precautions to prevent being surprised while gathering fodder. Though other factors also influenced strategy, the need for fodder dominated both strategic planning and military operations.

Throughout the first millennium AD, the Muslims were adamant about incorporating knowledge of terrain and vegetation when planning raids. Muslim planners devised contingency plans dependent on the seasons in that, during February and early March, their raids only lasted 20 days so they could get the horses back to Muslim territory to graze. Spring campaigns could only last 30 days, while summer ones were to last 60 because of the availability of fodder.[11] However, the Muslims were also sufficiently organized to set up a series of warehouses near their eastern frontiers over which they campaigned. Reports of these warehouses came in the 7th century and again in the 10th century relating the existence of ready supplies, "including grain and fodder [and] located where defensive or offensive action tended to repeat itself."[12] Despite the Muslim's successes, by the 18th century, few countries, except for the French and Prussians, had adopted a suitable fodder magazine system.[13] The French and Prussian magazine system, as well as the earlier Muslim warehouses, gave their respective forces the advantage of surprise and a greater measure of flexibility by allowing them to mobilize and attack more quickly.

As mentioned earlier, Alexander the Great grappled with the fodder problem throughout his farflung exploits across Europe. Alexander realized the problems posed by bringing along numerous horses and pack animals, so he attempted to minimize their numbers by requiring his men to carry packs.[14] He also understood that excessive work and not enough food would wear out his cavalry and pack animals and he would not be able to nurse them back to health.[15] Welfare for the horses dictated that he slow his army's pace so the horses and pack animals could graze. The need to move faster, therefore, motivated Alexander to look for new ways to reduce his dependency on horses. His massive fleet helped alleviate this problem by transporting large fodder supplies from port to port, though this locked him into a dependency on the Mediterranean coastline or large navigable rivers, especially during winter.[16] The need to provide fodder for his horses forced Alexander to work within increasingly narrow boundaries as he moved farther away from Macedonia. Alexander's campaigns provide one of the earliest recorded examples of logistical handicaps.

As long as armies required horses for cavalry and carrying supplies, the need to find fodder restricted flexibility and operations. In 1775, during the American Revolutionary War, American forces under General Philip Schuyler planned an invasion of Canada. However, lack of rain made for a hot, dry summer, and General Schuyler could not move up enough fodder to feed the horses needed for a full invasion. Instead, the lack of fodder forced him to wait until late summer when adequate rain nourished the grass enough to supply the invasions.[17] Winter quickly set in after Schuyler experienced early successes and cut him off from all resupply. The "inadequate forage in June and July was not the only reason for the failure of the Canadian campaign, but it surely was one of them."[18]

Fodder further affected flexibility during the American Revolution when free fodder became hard to obtain and the Colonial Army had to compensate farmers for using their land. Wartime prices steadily rose as good pastureland became less available. However, like Alexander, the American commanders understood that without adequate fodder their limited supply of horses would dwindle. Colonial commanders could send the cavalry away from the army to find cheaper fodder, but they needed the pack animals to stay close and often paid high prices for their nourishment."[19] Without the pack animals, the army could not transport its supplies and conduct operations for very long.

The US Civil War (1861 to 1865) demonstrated the importance of using a rail system to increase strategic flexibility by more efficiently supplying armies. Trains and rail lines came under attack as both sides sought to cripple the other's access to them and prevent valuable supplies from reaching their intended forces. Armies still required cavalry and pack animals to move their food and supplies while in the field and, therefore, continued to need fodder. However, with the locomotive's introduction into warfare, fodder and other supplies could be loaded onto trains and brought to depots within the army's proximity. Established supply lines could then be used to retrieve the materiel. The Civil War became the first conflict in which armies used the new technological innovation to improve logistics, especially resupplying fodder, and to alleviate the need to constantly change camps to find more fodder.[20] In fact, historian James A. Huston, in *The Sinews of War: Army Logistics 1775-1953*, relates that shipments of forage during the winter months averaged $1 million. He goes on to say that fodder continued to dominate supply considerations, in that "for tonnage and bulk the item of daily supply that was even more important than food for the men was food for the animals."[21] Trains permitted armies to receive more fodder while maintaining their positions and simultaneously allowed an army to keep more horses.

The period between the Civil War and World War I was filled with advances in technology, which were not fully taken advantage of by the European powers. Further, the dominant powers in Europe (France, Prussia, England, and Russia) failed to truly understand the lessons that could have been learned from the Civil War. Cavalry charges and long baggage trains of horse-drawn wagons persisted, and with that returned the age-old need to feed the livestock. In many ways, the First World War resembled all past wars. However, its rapid consumption of supplies, especially ammunition, dictated that the times and ways of war were changing. But for the moment, it was remarkably similar to the past, in that during the war, Great Britain shipped 5,253,538 tons of ammunition to France as well as the greatest single item shipped, which was 5,438,602 tons of oats and hay.[22] Fuel for horses continued to be a dominant factor.

Regardless of the lessons the Germans should have learned from the past, during World War I, they placed a huge emphasis on cavalry and did not prepare for their maintenance in the field. The German high command ordered commanders to feed their horses off the land as a result of the army's sheer numbers of horses. Van Crevald relates that any attempt to supply the army from home bases would have been impossible.[23] As the

Germans moved into France early in the war, luck appeared to be with them as the land was rich and the grain had just been harvested. However, much of the grain was still green, causing many of the horses to become sick and die very early in the campaign. A critical shortage in fodder resulted, and by the time of the Battle of the Marne, where French and British forces engaged and halted the German advance, most of the horses were too weak to keep up the pace.

The German invasion plan, known as the Schlieffen Plan, depended on the speed of the invasion, yet the horses employed in reconnaissance and pulling the heavy artillery were so poorly fed that they could not keep up the pace. Many died before the Germans crossed the border into Belgium. By 11 August 1914, preceding the Battle of the Marne, cavalry forces ordered a 4-day halt to find food for the mounts.[24] By the Battle of the Marne, the starved horses pulling the German artillery, which was the only arm that had a distinct advantage over French forces, could not keep up the pace. "By this time, too, one German army at least was finding that the state of the cavalry seriously interfered with operations."[25] The German high command's severe oversight of properly feeding the horses proved to be a decisive factor in the failure of the Schlieffen Plan.

Following the offensive stall after the Battle of the Marne, the consumption of supplies reached proportions unmatched by any previous war. However, this consumption rate could not have been maintained if the front had not stalled and remained stationary throughout the war.[26] Supply movement via horses would have been inadequate given the war's immense scale. Toward the end of the war, both sides began to introduce motorized transport on a very small scale and began to argue that "complete motorization of local transportation and the widespread use of combat vehicles would restore mobility to the battlefield."[27] Petroleum products, then, came into demand, and by the war's end, more than 759,000 tons of gas and oil had been shipped onto the Continent. War planners deemed the horse obsolete in favor of the more economical and faster moving petroleum-based machines.

Military Campaigns, Strategy, and the Need for POL

Following the First World War, armies began nurturing the technological innovations employed at the end of the war and subsequently developed a strong dependency on petroleum products by the beginning of World War II. POL significantly differed from fodder in that POL had to be manufactured away from the battlefield and then shipped to the battle area.[28] For the most part, fodder as a source of fuel for horses quickly became a thing of the past as armies became fully mechanized. The new machines could be worked harder and go farther and faster, and most important, the time of the year and the route taken by the army did not affect its fuel supply. Commanders could expand their range of strategic operations immensely and do more with less.

However, challenges quickly attached themselves to the new machines and their fuel supply. If army quartermasters did not constantly provide the machines with enough fuel, operators could not normally forage for it. In this respect, commanders lost a measure of flexibility, and the situation forced them to further employ technology to devise ways to overcome the new problems. The result involved underground pipelines and the Red Ball Express, in which a constant stream of trucks traveled distances of up to 400 miles to supply Patton's Third Army.

The beginning of World War II saw the German Army still reliant on horse-drawn transport. Hitler neglected to fully mechanize his transport vehicles, though he dramatically increased the number toward the end of the war.[29] Historian Julian Thompson relates that the Germans only possessed three motor transport regiments, for the whole army, capable of carrying 19,500 tons. In 1944, the Allies in northwest Europe could transport 69,400 tons to support 47 divisions. Thompson goes on to state, "Hitler's failure to build up the necessary capacity to provide the transport essential for mobile warfare was one of the principal reasons for the failure of the German invasion of the Soviet Union (Operation Barbarossa)."[30] Regardless of the German Army's deficit in mechanized transport, the Second World War became the pioneering conflict to be predominantly affected by fuel in the form of POL.

Following Germany's invasions of Poland and France, POL's role became readily apparent, and Allied strategists sought to cripple the Axis' ability to effectively employ fuel with US entrance into the war. Plans got under way to target the Ploesti oilfields in Rumania as strategists estimated that the fields had the capacity to produce 9 million tons of refined oil per year, though it only produced 4 million. Allied strategists understood well the Germans' primitive transportation system and the fact their small fleet of motorized transport vehicles had become extremely overburdened by the war's rapid geographic expansion.[31] Accordingly, the Allies did not attack Ploesti in the hopes of crippling the Axis refining capacity. Instead, they were more interested in destroying Ploesti's refining capability so Germany's limited transportation system would have to move the crude oil from the Ploesti area to other refining sites in Germany or France. The war had already severely taxed the Axis transportation system, and the Allies believed the extra strain would cause supply to other areas to fall apart.

The Allies launched the first Ploesti raid on 1 August 1943 and estimated that the Axis oil supply had been reduced by 3 or 4 percent.[32] It was originally believed the raid had destroyed about 40 percent of 6 months of Rumanian refining capacity or a loss of 1.8 million tons of refining capacity as a result of closing the refining facilities from about 1 week to several months.[33] However, the raid's after-action analysis indicated that Rumanian oilfields possessed twice their estimated production capacity, so subsequent raids would have had to destroy about 3 million more tons of refining capacity to begin really limiting Ploesti's actual refining capacity.[34] Though the mission proved to be successful, the Army Air Forces sustained a 30 percent loss, making a follow-up raid impractical.[35] The Allies moved on to other targets, and the Germans managed to quickly rebuild the facilities.

Evolving into a strategy to attack the entire Axis oil industry, the raid, despite its heavy losses, fueled an intense bombing campaign that managed to strike every major oil refinery in German-controlled territory. Ambitiously, the United States and Great Britain set out to severely damage the German oil industry and keep it subdued. Like Ploesti, the Allies' goal was to reduce the German refining capacity as well as the number of refineries available to cannibalize in order to rebuild larger, more productive refineries.[36] They wanted to present Germany with only two options: transport the crude oil to old unattacked refineries near Marseilles, France, where they were highly vulnerable, or stay in their present locations and attempt to rebuild between raids.[37] The Germans chose the second option, and the Allies timed return missions to prevent refineries from going back on line.[38] As German oil production suffered, so did its armed forces as lack of aviation grade fuel kept the Luftwaffe on the ground and forced the army to heavily dip into rapidly dwindling reserves.

The Germans failed to completely think the entire war effort through and suffered from inadequate fuel reserves. The German Oil Association advised the government that the oil reserves would only last for 5 months given the high rate of consumption. Germany made the reserves last longer by robbing from the civilian sector, but the effects of the Allied bombing after 1943 made the situation critical. Germany's aggressions in 1939 and 1940 were rewarded with its victims' oil reserves. A US investigation following the war relates, "In January 1941, aviation gasoline stocks were approximately 500,000 tons. When Germany conquered the Netherlands, Belgium, and France, about 1 million tons were secured."[39] However, by January 1944, aviation gas had been reduced to 240,000 tons, and by January 1945, it was almost nonexistent.[40] By May 1944, fuel shortages resulted in a drastic reduction in training hours, and operational time was limited strictly to air defenses.[41] The situation had become so critical that the Luftwaffe could provide little opposition to the Allied invasion on 7 June 1944. By 1945, it could not support German ground forces in the Battle of the Bulge after a successful ground offensive.

Germany's lack of fuel reserves also manifested itself in ground operations as the combined bomber offensive and the Allied advance prevented German recuperation. Following victory in North Africa and a successful invasion of Sicily, the Allies drove up the Italian peninsula until stiff German opposition along the Gustav Line halted their advance. The Allies initiated Operation Strangle from 19 March to 10 May 1944 to cut the Germans off from resupply and deplete their fuel reserves. Generally successful, Strangle did not dislodge the Germans, and Operation Diadem got underway on 11 May 1944 to increase German fuel consumption while reducing their resupply through interdiction.[42] Strategically, the Allies planned to dislodge the Germans while strategic bombing would prevent resupply in hopes they would run out of fuel.

Operation Diadem went according to plan, and by mid-May, 14 fuel depots had been critically depleted, and "the mobility of the entire army had been called into question."[43] German fuel was adequate to compensate for the defensive maneuvers necessitated by the Allied advance at the beginning of the operation. Yet, by early June, the effects of the campaign presented a very hard reality. The German armies had been in retreat for a week, and the American Fifth Army presented a constant threat.[44] Though this defense suited the mountainous terrain and the situation, it required a lot of fuel that the army did not possess. "By June 6, the army was making its moves piecemeal—a unit would move, exhaust its fuel, and wait for resupply."[45] Defensive maneuvers, the mountainous terrain, and movement at night saved the German Army from total defeat, but fuel's use in strategy and its subsequent effect on German strategy was enormous.

On 6 June 1944, the Allies launched Operation Overlord, and the invasion of Eastern Europe began. Original plans called for the Allies to steadily push the German Army toward the Rhine and then force surrender. However, after a massive aerial bombardment on 25 July, the Allies forced a gap in the German lines and then exploited it by pouring through armored divisions.[46] New tactical opportunities to quickly defeat the Germans presented themselves instead of the originally planned methodical push to the Rhine."[47] Patton's Third Army raced through southern France consuming an average of 350,000 gallons of fuel each day.[48] By 7 August, the Third Army had exhausted its fuel reserves, though it managed to maintain the rapid advance for another 3 weeks. Fuel supply reached critical levels from 20 to 26 August when both the First and Third Armies, pursuing the retreating German Army, consumed an average of more than 800,000 gallons of gas a day.[49] However, the supply lines had not yet become so long as to be unmanageable by theater logisticians, and the Allies had enough fuel to enter Paris on 24 August.

Pre-invasion planning called for the Allies to halt and wait for the logistical network of communications and food pipelines. However, their shipping successes and rapid advances into Paris with little German resistance called for a reevaluation of the plan. General Bradley, commanding the First Army, was quoted as saying, "Armies will go as far as practical and then wait until the supply system in [the] rear will permit further advance."[50] Basically, he proposed to move forward, taking as much ground as possible, until they ran out of gas. Once again, fuel requirements dominated strategic decisions and operational action.

Since World War II, POL has become increasingly important to keep an army going in the field. The past 50 years of technological advance have only optimized modes of transportation, not lessened the impact of fuel on strategy, tactics, and operations. While technological advances may reduce the amount of support equipment required for military operations and the size, lethality, or amount of munitions—all of which will further reduce lift requirements—similar advance is seen as unlikely for fuel. Arguably, fuel will remain the dominant logistics factor that limits strategic and tactical planning as well as actual operations for the foreseeable future.

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Chapter Eight

General Logistics Paradigm: A Study of the Logistics of Alexander, Napoleon, and Sherman

Alexander the Great

Alexander the Great is rumored to have wept upon the conclusion of his conquests because there were no longer any nations to conquer. To a large degree, it is true that at his height of power. Alexander was the ruler of the known world. The tales of his conquest take on a mythical grandeur in which he is located somewhere between a man and a god. "Alexander was in fact, a living myth, and unless we accept him as such we cannot begin to understand his history."[1]

Generalship and Military Professionalism

The almost superhuman view of Alexander is not a modern contrivance. In fact, throughout most of his life, Alexander was treated with godlike reverence.

> Led by a god they [the Macedonian Army] faced all dangers, and it was their faith in him as a supernatural world-hero, as much as his inborn genius for war, which made him not only the greatest of all the Great Captains, but which distinguishes him from all and each one of them.[2]

This unparalleled allegiance to Alexander coupled with his genius for integrating logistics concerns into every facet of his military theory, doctrine, strategy, tactics, and administration enabled the support of a world-conquering army.

Alexander did not rise through the ranks but inherited his position from his father, Philip. Likewise he inherited a formidable fighting force without equal in the ancient world. Alexander's *professional education* was enviable, to say the least. He received instruction in strategy and tactics from his father and was privately tutored by Aristotle. The negative legacy of Philip and Aristotle's tutelage was their incredible hatred of the Persians, referred to by both Philip and Aristotle as the barbarians. However, Alexander seemed to rise above the hatred of his father and mentor and developed an attitude toward conquered peoples, even Persians, that was key in ensuring logistical support across the vast empire under his control.

Military Theory, Doctrine, Strategy, and Tactics

B. H. Liddell Hart characterized Alexander's logistics strategy as "direct and devoid of subtlety."[3] Moreover, to a large degree, logistics concerns shaped Alexander's strategy and tactics. From the time of his initial defeat of Darius at Issus, through his campaign into Egypt, and his final defeat of Darius at Gaugamela (also known as the Battle of Arbela) Alexander displayed an acute awareness of the logistical requirements of his army. Alexander considered the logistics implications of every aspect of the campaign, from the route he took to the allies he courted, in successfully moving the Macedonian army across the relatively barren desserts of Asia Minor.

Alexander began his move east from Macedonia, intent upon engaging the Persians at the Gracicus River. He had an estimated 10 days' worth of provisions for his army at Hellespont.[4] Ten days' provisions were ample, given Alexander's close proximity to ports along the Aegean Sea and the relative friendliness of the people of that region. Upon defeating the Persians at the Gracicus River, Alexander then marched on Sardis. It was on his march to Sardis that he encountered his first great logistics challenge. The direct route to Sardis was across mountainous terrain. However, Alexander elected to take a more circuitous route, moving back toward the coastline rather than southward to Sardis. This move was indicative of his exceptional grasp of logistics requirements and their direct influence upon the fighting capability of his army. Had he chosen the more direct route, not only would the terrain have slowed his advance, but the greater strain of covering mountainous terrain would have increased the consumption of supplies by both his men and horses. In all likelihood, his supplies would have been exhausted prior to reaching Sardis, and his army would have been located in the mountainous region vice the coastal area with its ready access to supply ships. Alexander repeated this strategy of attacking the enemy then quickly returning to the coastal region for resupply throughout his campaign against the Persians. The two exceptions to this strategy were his move on Ancrya (modern day Ankara) and his expedition into Egypt.

Alexander achieved two major logistics objectives in his capture of Sardis. Sardis was the political and economic hub

of the entire region, and by bringing it under his control and raiding its treasury, Alexander further increased the resources he could draw. Second, the defeat of Sardis cleared his path southward along the coast of the Aegean. He then *liberated* Ephesus, Caria, Lycia, and Pamphylia. Alexander limited the Persian fleet's ability to move and took away their access to these ports by bringing these coastal cities under his control. A secondary effect of controlling these cities was that Alexander deprived the enemy fleet of a valued manpower resource. The Persians had been recruiting heavily from this area.[5] Alexander continued his coastal movement through Lycia and Pamphylia. While passing through this fertile region Alexander again illustrated his ability to integrate logistics requirements with the gamut of additional concerns facing the leader of a large force. Although the region was fertile and presented an excellent source of resupply for his army, he was well aware the effect mountainous terrain had on the consumption of supplies. Additionally, it was now winter. He chose to grant leave to newlywed members of his army. This act of altruism was, in fact, a brilliant means of reducing the army's consumption of stores, in addition to significantly improving morale. Though it seems unusual to grant leave in the midst of a campaign, Alexander was sensitive to the limits to which this region could support his army, and he did not intend to march on until the end of winter.[6]

Throughout his campaign, Alexander left garrisons of forces at key locations along his route. This practice had three major purposes: it ensured the allegiance of the city was secure, it allowed the city to serve as a depot for the storage of supplies, and it protected his lines of communication. In some instances, Alexander was able to send a small force ahead to secure a city's allegiance and support. His emissaries were able to secure logistics support and supplies, simply because the city's leaders desired to be in favor with Alexander.

Alexander's army remained throughout the winter and spring in the region around Pamphylia. He did not make his march to Ancyra until well into summer. The reason for the delay was purely logistical. He would be departing the coastline and heading inland. Given his doctrine of traveling light, his army would quickly exhaust its supplies and be forced to forage. Knowing that, Alexander began his march in late summer to ensure crops within the region between Pamphylia and Ancyra had an opportunity to both mature and be harvested, the latter being performed by the residents of the region, thus sparing his army that arduous task.[7]

En route to Ancyra, the Macedonian army crossed a region best described as an utter wasteland. Given the lack of potable water in this region, Alexander made frequent use of advance depots. He established the depots forward of the main army, with supplies from the rear augmented with whatever else could be secured at the advanced location.

Upon securing Ancyra, Alexander successfully consolidated his position in Asia Minor. He then marched to Issus and once again was forced to rely heavily upon the advance garrisons he had established, in addition to securing supplies from the local population en route. To his advantage, the majority of the cities between Ancyra and Issus were quite unhappy with their subjugation under Persian rule and viewed Alexander's cause favorably. Issus was a coastal city, which enabled Alexander to move forces garrisoned in the rear on the Aegean Sea forward. The army he had partitioned prior to his march on Ancyra was now back in full force at Issus. The partitioning and regrouping of his army aptly illustrates his philosophy of carrying only what was needed and could be supported. This applied to not only his supplies but also his troops.

Upon his defeat of Darius at Issus, Alexander departed from the direct conquest of Persia. He then turned southward through Phoenicia and eastward into Egypt. Although Phoenicia and Egypt were under Persian control, Alexander did not face serious opposition until his return to Asia Minor. Additionally, his logistics philosophy was consistent with his earlier actions along the coast of the Aegean Sea. His route in Egypt followed the coast of the Mediterranean Sea. The majority of the cities, especially those in Egypt, viewed Alexander as a liberator and not a conqueror and were, therefore, generous in their support of his army.

Upon his return to Asia Minor, Alexander again remained near the coast and its valuable seaports. The cities that he passed en route from Egypt were now directly under his control and represented an asset rather than a possible threat. His departure from the coast and march on Arbela was made through the fertile Tigris-Euphrates Valley. Though meeting the logistics needs of an army is no small task regardless of location, Alexander's march through the Tigris-Euphrates Valley was not marked by any significant logistics challenges.

Alexander's defeat of Darius at the Battle of Arbela marked the end of the Persian Empire and Darius as their king. Key to his defeat of Darius was his approach to Darius' main body at an angle and the rapid encirclement of Darius' forces by Alexander's left flank. Alexander's successful use of maneuver is directly attributable to his overarching philosophy of flexibility and mobility, a philosophy integrated into and facilitated by his logistics practices.

Administration and Technology

One of Alexander's logistics strengths, one for which he cannot wholly take credit, was the organization of his army. "Alexander had as a legacy a model instrument—the army which Philip developed."[8] Key to Alexander's combat superiority and logistics prowess was his staff. In addition to the traditional second in command, called the Secretariat, Alexander had Keepers of the Diary, Keepers of the King's Plans, Surveyors and Official Historians. In addition to the more traditional staff functions, he also kept a large number of specialists and scientists on his staff. This wealth of expertise, both operational and logistical, he kept close at hand and without reservation solicited their counsel. Alexander's use of his staff of experts made his army formidable, not only in terms of its ability to execute combat operations but also in terms of its ability to plan and support combat operations.

Under Philip's direction, the Macedonian Army also underwent a significant change in the manner in which troops

and provisions were transported. Philip outlawed the use of wagons in the Macedonian Army. This single act gave the Macedonian Army far greater speed and flexibility than any of their contemporaries. Philip's philosophy was expanded by Alexander, who limited the number of followers, civilians who tracked behind an army providing a gamut of services. Alexander only used horses, camels, and mules because of their greater speed and endurance over traditional pack animals such as oxen and donkeys.[9] The speed and flexibility of the Macedonian Army proved to be its greatest asset on many occasions

Social, Political, and Economic Factors

Philip, through his victory at Chaeronea, had secured control over Thebes and Athens. He then founded the Corinthian league and, through it, unified Greece. His next and ultimate goal was to destroy the barbarians, the Persians. His plans, however, were cut short with his assassination. Alexander was then left with the goal of conquering the Persians and, in doing so, laying claim to the known world. Despite his father's outright hatred of the Persians and the unbridled hatred of the Persians by Aristotle, his mentor, Alexander took a decidedly different view of his enemy. Alexander, too, saw the necessity of engaging and conquering the Persians. However, his purpose was well apart from the destruction of the barbarians. Under Philip, Greece had been unified, "and though he might have avenged Greece upon Persia, he [Philip] was not the man to carry the idea of *homonia* (unity in concord) into the world empire of his day . . . this supremely greater task was destined for his son."[10] Alexander's philosophy was not one of revenge and destructive conquest but one of control and ownership. When brought under Alexander's control, either through defeat, or in many cases by self-capitulation, a conquered city was left with a measurable level of autonomy.

His method throughout his reign was always the same. He separated civil administration from military control. The first he handed over to the representative of the conquered people, the second he placed in the hands of one of his chosen Macedonians.[11]

Alexander's goal was not for *homonia* just among Greeks but among all men, including Persians. In addition to the obvious political benefits this policy held, it provided substantial military logistics benefits. Although not completely free to choose whether or not to lend support to Alexander, conquered peoples, on the whole, favored life under Alexander's rule to that under some other conqueror and were generally supportive. On the off chance the *carrot* of semiautonomous rule did not persuade the conquered people, Alexander still had the *stick* of garrisoned troops left behind to oversee military affairs.

Napoleon Bonaparte

Napoleon is widely regarded as one of the premier generals of all time. He brought about numerous reforms in the way in which wars are fought and the very structure and composition of the fighting forces engaged in combat. Napoleon embodied the idea of the professional military leader, not gaining his position through political or familial connections, but earning it by distinguishing himself in combat. Although the focus of this study is on the logistics aspect of Napoleon's 1812 march upon Moscow, it first seems appropriate to recognize Napoleon for what he was, one of the greatest military leaders of all time.

Generalship and Military Professionalism

A major drawback to Napoleon's superior generalship and professionalism during the planning of the Russian campaign was his overpowering need to be involved in every aspect. An even greater problem than this, however, was his tendency to make decisions without consulting with his key leaders. There is a consensus among the accounts describing Napoleon's preparation for the Russian campaign that there were severe oversights regarding the logistic requirements of his army.

Although the planning for the Russian campaign was performed over the span of 2 years and showed some aspects of logistics consideration, it is clear Napoleon did not fully understand the logistical challenges he would face.[12] His misunderstanding, coupled with his reluctance to share information, had an obvious impact upon the soundness of the logistics aspects of his plan. His reluctance to seek the counsel of others was as much a function of "delusion and irrationality clouding his powerful mind" as the lack of any competent advisor. Just prior to the invasion of Russia, "there were few men left in the imperial entourage with sufficient integrity to speak their true minds," and "for the main part, Napoleon was now surrounded by claquers and sycophants."[13] Whether acting out of ego or necessity, Napoleon planned the Russian campaign, to a large extent, entirely on his own. Operating in a vacuum led to numerous logistics problems in terms of military theory, doctrine, strategy, tactics, administration, and technology.

Military Theory, Doctrine, Strategy, and Tactics

Throughout the planning and execution of the campaign into Russia, Napoleon committed numerous errors in terms of strategic focus and tactics, which directly affected the ability of his logistics system to support sustained operations. One of his greatest oversights was his doctrinal belief he could conduct a war on two fronts. When he began the invasion of Russia in 1812, Napoleon's forces were still actively engaged in a peninsular war with the Spanish. Though it is unclear as to his exact reasoning, Napoleon chose not to regard his commitment to the war in Spain. It seems he preferred to have the British involved on the side of the enemy in Spain rather than being involved in some other less convenient sector of Europe. Regardless of Napoleon's exact reasoning, the net negative effect of the Spanish War was the loss of 50,000 French soldiers per year and the consumption of an untold amount of the materials of war that could have been used in the Russian campaign.[14]

Though Napoleon did show some consideration for logistics, he viewed these requirements in a static sense. He

failed to factor in the possibility that the support he anticipated would not be available. Similarly, he did not consider the possibility that the enemy he wanted to destroy would not engage him.

Napoleon's strategy did recognize the materiel challenges to be faced by any force marching on Moscow. The date for the start of the invasion, 23 June, was largely chosen for logistics reasons.[15] Napoleon thought the crops in Russia would be sufficiently developed and provide adequate forage for the thousands of horses upon which he relied for transportation and as weapons of war. He also had the horses bear a larger-than-traditional load in an attempt to ensure an adequate supply of food for both man and beast. Unfortunately, the addition of the extra loads increased the horses' consumption of food, in essence negating or worsening the effect of the additional provisions. In very short order after crossing the Niemen River, Napoleon would see his fleet of horses cut down by a third because of an outbreak of colic, the relative lack of edible forage (on which he was counting), and incredibly hot weather. The loss of those horses had a cascading effect. Men who had been mounted were now forced to advance on foot, and horses were diverted from other details to fill vacancies in horse-drawn artillery teams. The net effect was to distribute the transportation and logistics burden over an ever-decreasing population of beasts of burden. The burden increased with the onset of heavy rains, which turned the Russian roads into impassable bogs. Throughout the campaign, the ever-dwindling supply of horses and the ever-worsening weather contributed to the complete destruction of Napoleon's ability to provide for his forces.[16]

The greatest strain on Napoleon's logistics system proved to be the Russian unwillingness to engage in battle. From the start of the campaign, the Russian forces were quite content in withdrawing and forcing Napoleon to pursue them. To compound this, they would also burn their own cities prior to abandoning them. Thus, the farther Napoleon marched into Russia, the farther he marched into a virtual wasteland. The Russians rarely left behind anything of use. Upon reaching his strategic goal of Moscow, Napoleon found it deserted and generally devoid of any useful supplies. The Russians, after fighting a pitched battle on the outskirts of the city and seeing the city would fall, simply deserted it during the night. The net effect of Napoleon's march on Moscow was that his army, some 250,000 strong when it crossed the Niemen, was reduced to 130,000 because of the lack of supplies, disease, and Russian hit-and-run attacks on Napoleon's rear. The Russian Army, which was outnumbered two to one when Napoleon crossed the Niemen, was now approximately equal in size to his army. Further, the Russian army, in spite of all its retreats, had stubbornly hung on to its artillery and enjoyed a slight numerical advantage over Napoleon's heavy guns. Upon reaching the strategic goal of Moscow, Napoleon was no closer to defeating the Russians than when he began, and he was now in the midst of a vast wasteland, several hundred miles from his stores of supplies in Warsaw.

In search of both victory and supplies to sustain his army, Napoleon marched on to Kaluga. It was en route to Kaluga that he obtained what he so desperately wanted—battle with the Russians. General Kutuzov made his stand at Maloyaroslavetz, a village on the road from Moscow to Kaluga. Although Napoleon was able to remove Kutzov's forces from Maloyaroslavetz, it came at the cost of 4,000 French troops. Worse yet, Kutuzov's forces still controlled the road to Kaluga. It was at this point that Napoleon began his retreat from Russia. Without losing a battle, he had lost the war.

It was now October, and 200 miles lay between Napoleon and his nearest supply depot, Smolensk. The depot at Smolensk was established on the march across Russia from Poland. Napoleon had charged the garrison commander to secure stores while the main body of Napoleon's army pressed onward to Moscow. Napoleon anticipated that upon the conclusion of the grueling 2-week march from Maloyaroslavetz to Smolensk he would be able to halt there and regroup. There were, however, three tragic flaws with this plan. The Russians were now attacking Napoleon's rear with great vigor. The garrison commander at Smolensk had precious few supplies at the onset of establishing the depot and, being surrounded by a virtual wasteland, had failed to secure any stores of adequate quantity. The weather was steadily deteriorating.

The strain on the weakened transport system was growing. All along the way, the men were discarding the bulkier and less valuable items among their loot. Rations were limited. Horseflesh began once more to be cooked at the evening campfires. Snow began to fall. And on the night of 5 November, the cold came.

No longer were the retreating troops faced with merely the unpleasant chill of frost. This was a cold that could not be held off by the upturned collars of their greatcoats. It could not be pushed aside by stamping in the snow or by holding cupped hands against ears and cheeks. This was cold so terrible that frozen feet, followed by frozen death, came upon men who had done nothing more than momentarily step into the ankle-deep water of some frozen roadside puddle on which a heavy artillery wheel, a moment before, had broken the ice.[17]

Upon his arrival at Smolensk, Napoleon realized his folly. There were no adequate stores at Smolensk, and he must keep moving, or his army would be lost. Throughout the retreat, the Russian Army dogged Napoleon's heels, at times separating the rear guard from his main body and inflicting even heavier casualties. When Napoleon finally returned from the Russian campaign, his army, once numbering 250,000, reported 8,800 men fit for duty.

Administration and Technology

The administrative weakness of Napoleon's army was directly attributable to his style of leadership. Although Napoleon's influence had garnered great success in the past, he made the tragic flaw of assuming what worked in previous situations would work again, despite the dramatic difference the Russian campaign represented from his previous conquests. Most important, Napoleon's army was larger than it had ever been, and the campaign was spread over the vast expanse of the Russian countryside.

The problems of time and distance were to prove too great for the capacity of a single mortal, even when that man was Napoleon. Napoleon's whole idea of warfare was based upon personal supervision of all parts of his army.[18]

His philosophy of direct supervision had proven difficult for him to execute over armies of smaller size that operated over a far more confined area. This philosophy proved impossible during the Russian campaign. Napoleon's inability to oversee his subordinates' preparation and execution of his planning led to significant shortfalls in readiness and synchronization of effort. The army's reliance upon guidance from the highest levels led to poor preparation and logistics support.

Technologically, Napoleon's army was the model of modern arms for the time. However, technological superiority in this case did not ensure battlefield superiority. Specifically, Napoleon's heavy guns required multiple horse teams. The horses in turn required provisions of their own. The only means of replenishing a lost horse was to obtain it from another function within the army. The net result, as mentioned earlier, was the logistics burden continually being spread over a decreasing number of pack animals. Furthermore, Napoleon's wagons were well suited for the relatively passable roads of western Europe but were woefully inadequate in the boggy mire of the Russian countryside. The combined net effect was a technologically advanced force incapable of getting to the battle in force and forced to consume itself in order to keep pursuing an enemy not committed to full engagement.

Social, Political, and Economic Factors

Leading up to Napoleon's invasion of Russia, Tsar Alexander was able to make peace with Turkey, sign a treaty of alliance with Great Britain, and court the favor of Crown Prince Bernadotte of Sweden. The collective effect of this diplomatic maneuvering was that Russia "was able to clear her hands of all outstanding commitments and proved notably successful in her search for new allies."[19] Although Napoleon made similar political attempts to garner support, the vast majority of his support was obtained by force. The Russians were fighting on their own soil, which provided many logistical advantages. Their supplies had shorter distances to travel, and their personnel were well equipped to handle the severe weather. Tsar Alexander eerily predicted the results of the Moscow campaign in a conversation with Armand de Caulaincourt, then Ambassador to St Petersburg.

> If the Emperor Napoleon decides to make war, it is possible, even probable, that we shall be defeated, assuming that we fight. But that will not mean that he can dictate peace. The Spaniards have frequently been defeated; and they are not beaten, nor have they surrendered. Moreover, they are not so far away from Paris as we are, and have neither our climate nor our resources to help them. We shall take no risks. We have plenty of space; and our standing army is well organized. Your Frenchman is brave, but long sufferings and a hard climate wear down his resistance. Our climate, our winter, will fight on our side.[20]

Logistics problems played the pivotal role in Napoleon's failed campaign into Russia. Inadequate transportation systems, reliance upon single sources of replenishment, and improper provisioning for extremes in climate reduced the greatest army of the time, some 250,000 men strong, to a feeble force of 8,800 survivors. Until his retreat, Napoleon had not lost a battle, but he did lose the war.

William Tecumseh Sherman

The concept of generalship, a person's ability to be a general, cannot be viewed simply in terms of his conduct and influence upon his surroundings. His surroundings must also be evaluated. The environment in which the general commands has a great deal to do with his success and, in turn, will clearly influence the overall perception of his generalship. An analysis of William Tecumseh Sherman's environment leading up to and during the march on Atlanta provides unique insight into his generalship and military professionalism and how these threads of continuity both influenced and were influenced by his logistics practices.

Generalship and Military Professionalism

Ulysses S. Grant's appointment as Lieutenant General, Commanding the Armies of the United States in 1864, served to solidify unity, not only in terms of command but also in sense of purpose. Grant was the field general under whose leadership Sherman led the armies of the West into the heart of the Confederacy. Sherman's success can, in large part, be attributed to the autonomy with which he was allowed to operate. This autonomy was brought about as much because of Grant's trust in him as because of his geographic separation from Grant. Grant, in his written direction to Sherman, illustrates his belief in outlining what needs to be done, not how to do it. "I do not propose to lay down for you a plan of campaign, but simply to lay down the work it is desirable to have done, and leave you free to execute it in your own way."[21]

This concept of centralized control and decentralized command was especially useful given Sherman's nature as a man of action. His conduct during the preparation for and subsequent march on Atlanta is distinguished by quick and decisive action. His focus was first on the end goal, then on achieving it. In terms of logistics support, Sherman clearly identified his logistics requirements, then obtained the necessary means to meet them. Sherman was not prone to micromanagement. He simply expressed his requirements, established a completion date, and then ensured adequate motivation for completing the task. An excellent example of Sherman's leadership style, as it specifically relates to logistics, was the case in which a subordinate was not providing adequate transportation support. Sherman informed the officer that if he did not supply his army and keep it supplied "We'll eat your mules up." Sherman was far more forgiving of tactical errors than errors regarding logistics planning. He believed tactical errors often "stem from the enemy's resistance and counteractions, which are the most incalculable factors in war,"

but a failure to adequately prepare was intolerable. Sherman believed "by due foresight, preparation and initiative, material obstacles can always be overcome."[22]

Sherman enjoyed the benefit of the best military education available in the United States at the time. He was a graduate of the United States Military Academy. Despite not holding any cadet positions of authority while at West Point, he graduated near the top of his class, number six in the class of 1840.[23] The military education he received at West Point proved valuable because it provided a sound background upon which to build military command experience and was the same background the majority of the military leaders of the time had. Grant, Lee, Jackson, and numerous other Northern and Southern generals came from the same school of thought, West Point. The classical approach to education at West Point undoubtedly exposed Sherman to the histories of great generals and campaigns of the past. It is then not surprising that there are significant similarities between Sherman's campaign into the heart of the South and Alexander's campaign against Darius.

Military Theory, Doctrine, Strategy, and Tactics

Sherman, in his memoirs, makes two points clear regarding his planning for the campaign on Atlanta: adequate supplies and maneuverability were key to the success. "The great question of the campaign was one of supplies."[24] Sherman was well aware of the relative length and vulnerability of his supply chain and took many creative steps to ensure he was provided adequate support.

Sherman was adamant about ensuring the highest maneuverability, while still maintaining adequate support.

> I made the strictest possible orders in relation to wagons and all species of encumbrances and impedimenta whatever. Each officer and soldier was required to carry on his horse or person food and clothing enough for five days.[25]

Sherman gave strict orders regarding the number of wagons and ambulances each regiment was allowed in addition to banning the use of tents by his army. The ultimate goal of Sherman was to strike a balance between maneuver and support. Sherman required each soldier to carry sufficient supplies for 5 days, yet he relieved units of the burden of carrying *nonessential items* such as tents, excess wagons, and ambulances. Sherman's key focus during the planning of the Atlanta campaign was to make his "troops as mobile as possible."[26]

Sherman was well aware of the possibility of not receiving adequate support despite the many actions he had taken in preparation for the Atlanta campaign—the increased buildup of supplies at the front, commandeering of the railroads, and strict limitations he placed upon his army. Sherman bluntly informed General Grant of his anticipated course of action should his supply system fail to support him.

> Georgia has a million of inhabitants. If they live, we should not starve. If the enemy interrupt our communications, I will be absolved from all obligations to subsist on our own resources and will be perfectly justified in taking whatever and wherever we can find.[27]

Sherman's strategy and tactics in terms of logistics were then clear: a highly mobile force that would rely upon significant logistics support from the rear; whenever this support was interrupted, whatever was required would be taken from the local inhabitants. The plan of taking what was required from the local population further supported Sherman's overarching doctrine of bringing the horror of war to the people of the South.[28]

From the onset of the campaign into Atlanta, Sherman's strategy emphasized maneuver and focused on logistics. Specifically, Sherman's desire was to feign an attack on the Confederate forces at Dalton while engaging in a rear action to bar the retreat of the Confederate forces farther south to Resaca. If the Confederate forces were allowed to retreat south to Resaca, Sherman not only would face the burden of being farther from his main supply depot but also be driving the Confederates closer to theirs.

Unfortunately for Sherman, his plans for a rear action were not completely carried out. Due to a lack of initiative on the part of one of his subordinate commanders, Sherman's army failed to attack the rear decisively, and Sherman's attempt to execute a rear action failed to reach complete fruition. However, Sherman's actions did have both a negative and positive result. The Confederate forces were drawn away from their fortified position in Dalton to a far less favorable position with their retreat through Resaca across the Oostenaula River.

It was nevertheless a brilliant achievement to have maneuvered so renowned a master of defense [General Johnston, Confederate commander at Dalton] out of two strong positions against his will and his orders.[29]

The negative result of the Confederate retreat was that Sherman had missed a golden opportunity to trap Johnston's army and attack it from the rear. "Sherman had a lengthening line of communication [and supply], Johnston a shortening and less exposed one."[30]

Throughout the remainder of Sherman's march to Atlanta, he was able to effectively employ maneuver to force Johnston backward while continually supplying his troops from the rear. Essential in the resupply effort was a trailing echelon of 2,000 troops under the command of Colonel Wright, a civil engineer, whose expertise in the repair of enemy-damaged railways enabled virtually uninterrupted resupply to the forward lines beyond Resaca. "Time after time, Sherman's greater army outflanked Johnston's lesser forces, compelling their withdrawal."[31] Sherman eventually won the Battle of Atlanta and captured the city.

Administration and Technology

The Civil War arguably was the first modern war, especially when considering war in terms of the American experience. The North, in particular, was a highly industrialized region capable of producing a variety of both durable and consumer goods. One key necessity of industrialization is the need for rapid, reliable transportation. In the late 1860s, the railroad

developed as an indispensable mode of transportation for both military and civil concerns. Sherman, well aware of its importance, made the acquisition and maintenance of rail transportation, while denying it to the enemy, a priority.[32]

Chattanooga, the starting point for Sherman's advance on Atlanta, lay 151 miles from his supply depot at Nashville, which in turn was 185 miles from his main source of supply in Louisville. Given the significant length of Sherman's lines of supply, it was of paramount importance that he secure adequate transportation for supplies and reserves. His first step in ensuring a reliable line of supply was to acquire supreme control of the railroads. Previously, the railroads had been controlled by "the departmental commanders, with consequent friction and uneven distribution of supplies."[33] He much like Grant had done for the entire Union Army, unified his control over this critical resource. Sherman then decentralized execution while maintaining overall control. His philosophy of overarching control and decentralized execution of railroad operations resulted in two largely beneficial effects. He was able to oversee the flow of supplies to the front without directly involving himself in the *ins and outs* of rail operation, and he eliminated the bickering and supply imbalance between subordinate commands. A secondary effect of Sherman's control of the railroads was his ability to weigh in with the authority of his office should any problems arise.

He further ensured the availability and proper use of railroads by banning civil traffic. Still not satisfied, despite the fact his daily delivery of stores to the front had doubled, Sherman directed that cars and locomotives from other locations be diverted to the Chattanooga line. The decision to ban civil traffic and commandeer additional cars was not an attempt to simply bring a valuable resource directly under his control. He had a clear level of support in terms of rail shipments, 130 ten-ton car loads per day, he felt must be met, and taking control of the railroads seemed the logical way to do it.[34]

Sherman also displayed his penchant for centralized control and decentralized execution in both his mode of operation and his army's organization. An excellent illustration was the composition of his staff. His staff included functional experts in artillery, engineering, ordnance, logistics (actually called Chief Quartermaster and Commissary) and medicine. In addition to the functional representatives, Sherman's staff had three inspectors general and three aides-de-camp. Conspicuously absent from his staff was the administrative function. He advocated that clerical work in the field be kept to a minimum and used permanent clerical offices in the rear for daily correspondence. The composition of his staff facilitated the scheme of centralized control by using the staff in a controlling capacity while still leaving the execution to the lower echelons.

Social, Political, and Economic Factors

The political motives behind Sherman's campaign were clear: to bring the war and all its horror to the heartland of the South. "Sherman was eager to teach the people of the South a lesson in the horrors of war, believing that a harsh war would ensure a lasting peace."[35] Sherman further believed he was justified in his laying claim to any and all stores before him, shaking off the "old West Point notion that pillage was a capital crime."[36]

Analysis

Though it can be maintained that the two largely successful campaigns of Alexander and Sherman had many similarities among policies and practices, it cannot further be assumed that there then exists some exacting set of rules or practices shared by the two that will always guarantee success if employed. This study does not attempt to develop a listing of the key logistics principles that will guarantee success but, rather, establishes a logistics paradigm intended to be a guide or a starting point from which current and future military leaders can develop their own policies and practices. By analyzing the commonalities among successful campaigns and integrating those with the lessons learned from not-so-successful campaigns, a logistics paradigm is developed that is based upon practices proven to be valid in antiquity, which forms a starting point from which leaders can tailor their own practices to fit their specific situations. The campaigns of Alexander and Sherman illustrate the good logistics practices, while Napoleon's campaign into Russia provides the lessons learned. The framework for analyzing the commonalities and lessons learned is based upon the threads of continuity approach.

Generalship and Military Professionalism

In terms of formal military education and background, backgrounds of Alexander and Sherman are dramatically different than that of Napoleon. The former represent the aristocratic general, while the latter represents the journeyman solider. In no way does that mean Napoleon was a lesser general. He is arguably one of the greatest generals of all time. What is meant by the distinction between aristocratic and journeyman is that both Alexander and Sherman were taught to be generals and leaders of men, while Napoleon was first taught to be a soldier and, through aptitude and hard work, rose to his position as general. Both Sherman and Alexander received superior education and military training compared to their contemporaries. Alexander's private tutor was Aristotle, and he was taught by his father, Philip, from an early age how to be a general. Sherman attended the United States Military Academy and was commissioned as a second lieutenant, with the focus of the United States Military Academy on teaching men to be leaders and, ultimately, generals. Napoleon, though a graduate of l'Ecole Militaire, did not have the formal military education of Sherman. L'Ecole Militaire during Napoleon's time was not "particularly distinguished for the attention it paid to the proper preparation of its young aspirants for commissions."[37] Similarly, given Napoleon's middle-class upbringing, he was not afforded the tutelage of a great thinker, and his father was not a great general.

Though no direct correlation can be made about the military education received by Alexander, Napoleon, and Sherman and their general logistics practices during the campaigns under study, their backgrounds provide insight into the disposition and character of these generals. It can clearly be seen that by working his way up from his middle-class beginning through the ranks as a junior artillery officer, Napoleon developed a significant sense of self-reliance and, as was the case during the planning for the invasion of Russia, a need to be involved in every aspect of the operation down to the minutiae. Conversely, both Sherman and Alexander consistently maintained supervisory oversight of their armies while leaving the precise execution of daily operations to their functional experts.

Military Theory, Doctrine, Strategy, and Tactics

Military theory, doctrine, strategy, and tactics, for the purpose of this analysis, are focused at the operational level and can be viewed in general terms as to how each general conducted the campaign. Each of the three campaigns represents dramatic differences in how the conduct of war influences or is influenced by logistics. Alexander's conduct of his campaign was greatly influenced by logistics concerns. Napoleon's logistics practices were greatly influenced by how he intended to conduct his campaign. Unfortunately for Napoleon, how he thought he was going to conduct the campaign was not how he ended up conducting it, and his logistics system proved horribly inadequate. Sherman's conduct of his campaign was influenced by logistics concerns and influenced his logistics practices.

Alexander's foremost concern was the adequate provisioning of his army, as is evident in his route through Asia Minor. Though the defeat of the Persians was the ultimate military goal of his conquest up to the Battle of Arbela, clearly that could not be accomplished without first addressing the logistics needs of his army. Throughout his campaign, Alexander employed three main techniques to ensure adequate provisioning. First, he stayed as close to the coast as possible. His proximity to the coast facilitated easy access to his fleet of supply ships while denying port access to his enemy. Second, he modified the size of his army (flexible sizing) to suit the environment he was facing. An excellent example of this was when Alexander, faced with the onset of winter after passing through the region around Pamphylia, granted leave for all newlywed members of his army. The granting of leave greatly decreased the number of troops he had to supply and undoubtedly had the additional benefit of increasing morale. Finally, when he marched inland, he took great pains to ensure advance logistics support. He sent military envoys ahead with the charter to inform local officials of his approach. The message was clear; surrender yourselves and your property or be destroyed. As was often the case, support was granted without the use of force.

Napoleon's *hubris* was that he failed to fully understand the environment in which he was to conduct war and, therefore, developed a logistics system that was woefully mismatched for that environment. The most popular example was the inadequacy of Napoleon's wagons to effectively negotiate the rough Russian countryside. However, a closer examination indicates the problem was just as much about what he carried and how he carried it as what it was carried in.

Though Napoleon had planned the start of the invasion to coincide with the harvest in western Russia, the availability of crops proved inadequate to support the thousands of horses he relied upon for transportation and as weapons of war. The lack of fodder, combined with an outbreak of colic, decimated his fleet of horses and had the cascading effect of spreading the burden over an ever-decreasing number of horses, which in turn increased their consumption of supplies. Worse yet, as the number of horses decreased, horses had to be shifted from pack details to pulling artillery. The shortage of pack horses meant more was being carried by men, increasing their consumption and reducing their mobility.

Napoleon's greatest misunderstanding was how the Russians would respond to his advance. The Russian willingness to trade land for time proved to be Napoleon's undoing. As Napoleon pressed farther and farther into Russia, he traveled farther and farther away from his main supply reserves in Poland and farther into a vast wasteland. The Russians laid waste to anything of logistical value prior to retreating, leaving Napoleon with little to draw upon from the local population. The Russian *scorched earth* tactic, accompanied by constant attacks on Napoleon's lines of supply, deprived Napoleon of even the slightest relief. By the time Napoleon was able to engage the enemy face-to-face, his 2-to-1 superiority in numbers had vanished. With the onset of winter, he realized the war was lost, and in his desperate march back to Poland, he lost the bulk of his remaining troops.

Napoleon began the campaign with the anticipation of relying upon the available crops within the area to augment the provisions his army carried with them. Additionally, he intended to bring his superior numbers and firepower to bear against an enemy in an army-to-army confrontation for the control of the capital. Unfortunately, what he encountered was something far different. Had events gone as Napoleon expected, it could be argued that he well may have won in Russia. However, Napoleon's logistics plan and practices proved woefully inadequate in the end.

Sherman's logistics policies and practices influenced and were influenced by how he conducted his campaign. Sherman was well aware of the logistics strain and the vulnerability of his lines of supply as he advanced toward Atlanta. He took unusual measures to bolster his lines of supply. From the planning stages through the execution of the campaign, he maintained control of the railways. He diverted locomotives from other locations and aggressively repaired battle-damaged rail lines. His route southward followed the main rail line from Chattanooga to Atlanta. Clearly, in this instance, his conduct of war was influenced by logistics.

Sherman is noted for the destruction that he brought to the heart of the South. The destruction he inflicted was neither solely the result of pillaging for supplies nor the result of pure malice and wanton destruction but a combination of both.

Sherman was clear from the onset of the campaign that one of his motives was to bring the war to the people of the South. He also considered himself completely justified in obtaining whatever he required from the local population. He believed if the Confederate forces impeded the flow of supplies to the front he was then perfectly justified in acquiring the supplies he needed from the local population. Whether it be the case that the Confederate forces significantly affected Sherman's supply lines or that he simply needed more supplies than he could provide for himself, before the onset of the campaign, he clearly established his intention to take what was needed from the local population. Sherman allowed his desire to bring the horror of the war to the people of the South, a key element in how he was to conduct this campaign, to influence his logistics practices.

Sherman and Alexander shared one key factor in their conduct of war: the logistics requirements they placed upon individuals during the planning stages of their respective campaigns. Both gave specific instructions aimed at lightening the load of individuals and individual units under their commands. Interestingly, both Alexander and Sherman prohibited the use of tents. Alexander built upon Philip's requirements and minimized followers, while Sherman limited the number of wagons available to individual units. The ultimate end goal was to increase individual and unit mobility by limiting to the bare essentials what was carried. This is not to say that Napoleon did not take measures to increase mobility and in turn increase the army's ability to maneuver, but in the case of Alexander and Sherman, maneuver proved to be the deciding factor in the defeat of their enemy. Sherman was able to outflank Johnston's forces, and Alexander was able to attack Darius' forces at an angle and encircle them. Both victories resulted from the successful use of maneuver, which was directly attributable to their armies' ability to move quickly, a concept integrated into and facilitated by their logistics policies.

Administration and Technology

A key attribute shared by both Alexander's and Sherman's success, which proved to be a contributing factor to Napoleon's failure, was the use of their staffs. Both Alexander and Sherman had experienced and trusted military advisors to advise them on a multitude of functional areas. Though Napoleon also had a staff, his, to a large degree, was made up of *claquers and sycophants*.[38] It is unclear if the lack of sound advisors resulted in Napoleon's tendency to micromanage or if his management style made a staff position an overly unattractive billet for anyone except a sycophant. Regardless of the cause for his less than competent staff, its lack of competence left Napoleon with little choice but to rely upon his personal involvement in all aspects of the operation of his army.

As discussed earlier, both Sherman and Alexander, to a large degree, dictated what was to be done but not how to do it. Such a philosophy is an excellent indicator of a high level of trust and respect for one's subordinates and indicates a capable and competent staff.

Each of the three armies represented the most technologically advanced fighting forces of their time. They differ, however, in how they adapted their technology to fit the situation at hand. Napoleon had state-of-the-art weaponry, especially artillery, yet he was unable to use it effectively because he could not transport it effectively. The wagons carrying his artillery were well suited for the well-maintained roads of Western Europe but were woefully inadequate in the impassable bogs of the Russian countryside. Alexander, on the other hand, purposefully did not use traditional pack animals, such as oxen and donkeys, but opted for animals with better endurance and speed, such as horses and camels. Alexander adapted his transportation technology to suit the situation. Sherman took complete control of the railways and ensured he had a viable repair activity prior to the start of the Atlanta campaign. He exploited available technology to his advantage while denying the enemy access to it. Similarly, Alexander made great use of naval resupply and, in doing so, denied the enemy similar access since he controlled the ports. Alexander's and Sherman's ability to adapt and apply logistics technology, specifically transportation technology, rather than their absolute technological superiority, proved valuable in the success of their campaigns.

Social, Political, and Economic Factors

To analyze the effect of social, political, and economic factors, this study examines the interaction between the campaign forces and the indigenous peoples and local environment. Although each of the three campaigning forces interacted differently with local inhabitants, there is one common aspect that defined the interaction. In the case of the successful campaigns, the commander understood the environment he was to operate in, to include not only the tangible factors such as terrain but also the intangible factors such as the resolve and attitude of the people he intended to conquer.

As discussed previously, Napoleon's failure to comprehend Russian resolve and willingness to sacrifice land for time was key in his defeat. In his statement to Armand de Caulaincourt, Tsar Alexander was quite clear about the Russian willingness to use the vastness of their frontier and the severity of their climate as key aspects in their defense. Apparently Napoleon failed to regard these comments or simply thought that even if the Russians did employ these tactics they would be of little impact. Napoleon was also willing to begin his offensive against Russia while still engaged in a war with Spain. He neglected to realize that a fundamental building block to alliances is a common enemy. Unfortunately for Napoleon, the fact that France was engaged in two wars made France far less attractive to any new prospective allies than Russia, who had settled all her other disputes. The net result was Russia was able to form alliances with Great Britain and Sweden and make peace with Turkey. Napoleon failed not only to comprehend the impact of the physical environment upon his logistics plan but also to recognize the political environment's effect upon his logistics plan. Russia had gained new allies and made peace with former enemies, which allowed her to

focus on the entire military logistics capability toward a single foe. Unlike his Russian enemy, Napoleon was now actively engaged in fighting a war on two fronts, with the bulk of his allies being former conquered peoples whose support was tenuous at best.

Sherman understood well the environment he was to encounter during his campaign. One of his specific goals was to change the environment of the enemy citizens he encountered. Atlanta and the surrounding region represented a wealthy and pristine area of the South, particularly in terms of its exposure to the destruction of the Civil War. Sherman conducted his campaign "aimed at defeating the South psychologically as well as militarily."[39] He was dramatically successful in both aspects. Sherman not only successfully completed his campaign to capture Atlanta but also left a lasting mark on the consciousness of the enemy population he encountered. Sherman clearly understood his environment and made affecting that environment a key factor in his campaign.

Alexander, too, was well aware of the environment he was to encounter. He, however, took a decidedly different approach than Sherman. Alexander allowed the conquered people to retain some measure of autonomy with regard to their own civil affairs. Additionally, the people he encountered often surrendered to Alexander without a fight and in some instances viewed him as a liberator from the oppressive rule of the Persians. The conquered peoples' view of Alexander is in stark contrast to how Napoleon and Sherman were viewed during their respective campaigns. Alexander's goal, too, was different from that of Napoleon or Sherman. Where Sherman explicitly wanted to make war on the people of the South and Napoleon wanted to conquer the people of Russia, Alexander, to a large extent, wanted to unify, under his rule, the people he conquered. This distinction between conquering and unification on the surface may seem subtle, but examination of how conquered people were treated by the two generals illustrates the dramatic difference between the two concepts. Alexander retained military control but, to a large extent, left the civilian population to continue their lives as they had done before. Napoleon, in contrast, retained control through the establishment of some puppet civil and military leadership. The net result was those under Alexander's rule, to a large extent, were unaffected by the shift in power, whereas former enemies under Napoleon's control were much the worse for the shift in power. Clearly, Alexander realized that if he was to accomplish his goal of *homonia* he would have to ensure the eventual and lasting support of the people. *Homonia* could not effectively be accomplished at the point of a spear. By understanding and integrating the political and social environment of the people he conquered, Alexander obtained their support, a factor that played a major role in his logistics practices during the campaign to defeat Darius.

Conclusions

The conclusions set forth in this article result from an examination of the events surrounding the campaigns examined and an analysis of the commonalties among successful campaigns and lessons learned from the not-so-successful one. The logistics paradigm resulting from this analysis has four key principles. Each principle of logistics put forth by the analysis relies upon the use of demonstration by "revealing a necessary connection between the defining properties of the object being compared."[40] Key to the validity of the logistics principles, and in turn the entire paradigm, is the underlying assumptions specifically outlined with the explanation of the principles. The assumptions form the framework in which the application of the principles apply as per the demonstration.[41]

It can easily be seen the four principles of logistics offered by this article are not entirely new to anyone familiar with the study of war. In fact, in some form or another, each of these principles appears in several prominent historians' statements of principles of war and/or logistics. However, the method with which these principles can be applied distinguishes them from previous theory. The difference between the principles put forth in this article and other theories will be discussed, but the principles themselves must first be described.

Centralized Control, Decentralized Execution

As described earlier, both Alexander and Sherman made extensive use of staffs of functional experts. Conversely, Napoleon, though possessing a staff of his own, tended to be involved down to the lowest operational levels. The logistics challenges Napoleon faced would prove too great for any one man to handle, even if that man was Napoleon.[42] Sherman and Alexander allowed their functional experts to manage the daily operations of their specific area of responsibility, and both generals weighed in with the authority of their office only when needed. Their management philosophies allowed them to focus on the overall management of their armies, while still staying close to the daily operations managed by their staffs.

Although these campaigns involved large armies and the necessity for centralized command and decentralized execution seems well founded, there is just as much applicability of this concept for smaller sized, more modern military units. Given the assumption that logistics concerns are a function of the complexity of the operation at hand, which is, in turn, a function of the people, equipment, and supplies being used, then the challenge of meeting basic logistics requirements has increased in proportion to the complexity of the fighting force. Though the size of the army or military unit may be quite different from that of Alexander, Napoleon, or Sherman in modern times, it is still quite complex. Complexity then implies the need for exacting expertise in numerous, specific fields integrated to support an overarching end goal or mission. In much the same manner that even a general as brilliant as Napoleon could not manage the wide gamut of logistics and nonlogistics issues he faced during the campaign into Russia, neither can a modern military leader expect to have adequate knowledge in the gamut of functional areas of responsibility. Though an extensive staff may be neither

practical nor attainable, a leader should be willing and endeavor to consult the functional experts.

Key to the validity of centralized control-decentralized execution and its implied reliance upon functional experts is that such experts exist and are available. This assumption seems negligible, but the availability of a competent staff or group of advisors is quite rare in small military units. Of even greater concern is the lack of true functional experts. Though career broadening and the blurring of the lines between logistics specialties in the modern military does provide an increased pool of *trained* personnel from which to draw upon to fill logistics billets, it necessarily results in the reduction of true functional experts who have spent the bulk of their career learning their specialty and honing their skills to a superior level. The greatest challenge to the concept of centralized control and decentralized execution is the loss of true functional experts.

Flexibility

The need for flexibility seems to be an item of consensus among students of military history. Flexibility is analyzed in this article as the degree to which forces can adapt to their environment, specifically, how logistics policies and practices enable forces to quickly adapt to their environment. Both Alexander and Sherman made advance orders to their armies specifically outlining what they could and could not bring with them, the ultimate goal being the most mobile force they could possibly have. Alexander and Sherman used maneuver as a key tactic in the defeat of their enemies. What is not so well documented, but equally important, is how their ability to move rapidly between battles further enhanced the capability of their armies. Napoleon, on the other hand, was unable to maneuver with any success and was forced to plod along the Russian countryside, enabling the enemy before him to retreat and lay waste to anything of value prior to his arrival. The flexibility to move and maneuver was clearly key in the success of Alexander and Sherman and was integrated into all aspects of their armies, to include their logistics planning and practices.

Additionally, this article examines flexibility not only in terms of an army's ability to respond to the physical aspects of the environment but also in the more intangible aspects of the environment. Napoleon very well may have been able to overcome the hardships he faced crossing the Russian countryside if he had an enemy to fight directly in battle. Ironically, it was the lack of an enemy that led to his eventual defeat. In taking Moscow, Napoleon fully expected the war to be won. When Napoleon marched into the capital largely unopposed, he was no closer to defeating the Russians than when he began his campaign. The Russians simply abandoned Moscow and, after Napoleon's arrival, set parts of the city ablaze. The intangible factor of Russian willingness to trade land for time proved to be the downfall of Napoleon's logistics plan. Though it cannot be said if his logistics plan would have adequately supported his troops had he been able to conduct the war as he had planned, it can be said that his logistics plan based upon the invasion of Russia and the ultimate capture of Moscow was not capable of sustaining his army in the protracted conflict into which he was lured.

Flexibility is the key to the success of any organized unit, military or otherwise. If an organization cannot adapt to changes in the physical and intangible factors which encompass its environment, then it will become extinct. The challenge in developing, obtaining, or maintaining flexibility is that it, in some sense, presumes clairvoyance. Clearly, it is easy to identify factors that at present must be adapted to or overcome. It is an entirely a different matter to plan for factors—or contingencies— before they manifest themselves, the mark of true flexibility. The measure to which a unit can respond to unforeseen contingencies is the true measure of the unit's flexibility. Therefore, the principle of flexibility implies the assumption that measurable flexibility is the result of planning for immeasurable and unforeseeable contingencies. Additionally, every contingency that is planned for and not encountered is needlessly planned for. The paradox is there is no way to know with any surety which contingencies will arise and which will not. The lack of a spare tire is only problematic when a flat tire is encountered. Otherwise, the omission of a spare tire represents additional cargo space and possibly better gas mileage. Flexibility then is more an aspect of the art of logistics than the science of logistics. It is both logistically and economically not feasible to plan for every possible contingency, but to the largest degree possible, logistics plans should be adaptable to the gamut of most likely contingencies. Quality planning and experienced logistics leadership can go a long way in the development of viable contingency plans. The major factor in ensuring flexibility, however, is not to attempt to analyze every possible contingency and then plan for it. In fact, this will result in excessive waste, and as pointed out earlier, those contingencies not encountered are needlessly planned for. The key is to develop a logistics plan that at its core is highly adaptive, meaning it requires the minimum possible support from external agencies. By having a highly adaptive logistics plan, the unit's reliance on its environment is minimized, allowing it to function unencumbered in a wide variety of environments, thus enhancing flexibility.

Proper Application of Technology

Both Alexander and Sherman not only properly applied the technology available to them but also integrated this technology into their logistics support practices. Alexander made use of nontraditional pack animals because they better fit the environment in which his army was operating. Additionally, Alexander made use of sealift whenever available. The capture of enemy ports and the coastal route Alexander followed illustrate how he integrated transportation technology into his overall strategy. His route and the ports he captured enabled him to exploit available shipping while preventing his enemy from doing the same. Similarly, the use of shipping enabled better and more rapid resupply, further enhancing his capability to execute his strategy. Sherman,

prior to the march on Atlanta, was well aware of the critical role railroads would play in his preparation and execution of the campaign. He took the unprecedented step of bringing this critical asset under his control to ensure its proper use and application in support of his efforts. Furthermore, Sherman had the foresight to form and utilize a rail repair force of some 2,000 troops. The rail repair force enabled the quick repair of any damaged rail lines and resulted in the preservation of this valuable transportation technology.

It cannot be said, however, that technologic superiority necessarily equates to victory. Napoleon's force at the onset of the Moscow campaign represented the most technologically advanced force of its time. Additionally, it enjoyed numeric superiority over the Russian forces by whom it was ultimately defeated. The key in Napoleon's case was that he was unable to exploit his technological advantage, or in other words, he failed to properly apply the technology available to him. There are numerous instances throughout recent history in which a technologically superior force was defeated by a technologically inferior enemy, but those conflicts are not the focus of this article. In a broad sense, technology can be seen as a single tool. No matter how advanced the tool, if it is used improperly or if it is the wrong tool, it simply will not work.

For modern military leaders, the challenge to the proper use of technology is that in most instances leaders do not have the leeway to determine the technology they employ. This is most true in terms of the actual weapons a unit employs. The critical assumption regarding the proper application of technology is that there is some choice regarding the technology that can be used. The greatest leeway, in terms of technologic choice, is in how the weapons of war, to include troops, are provided. It is true in this case the most technologically advanced method may not always be the best method. Though airlift in its own right might be the fastest mode of shipment, attempting to airlift an entire support package may result in a bottleneck and lengthy delays awaiting available air transport. The ultimate result may be the support package, had sealift been used, would have arrived earlier than by air due to sealift's ability to handle a larger capacity of freight. Similarly, the best way to provide potable water is to employ portable water purification units. However, this application of advanced technology is only of use if some source of water exists. This may not always be the case in extremely arid regions. The examples are numerous and further illustrate that superior technology is only of use if it is applied properly or can even be applied at all.

Understand the Environment

A major function of logistics is the neutralization of the effects of the environment. Clearly, it follows that to neutralize the effects of the environment the environment must be understood first. The paradox is the ability to completely understand the environment is beyond the capacity of any individual or group of individuals. This problem is further compounded by the fact that the environment can be defined in varied terms or at varied levels of precision. For example, the United States can be defined as the 50 states and all territories. An equally valid description is that the United States consists of all those individuals who consider themselves American. Furthermore, the United States can be defined in terms of longitude and latitude. The course of action offered by this article is that, given the environment is at best vaguely defined, the key to understanding the environment is to define as much as can be defined and then integrate control, flexibility, and technology in such a manner as to minimize the effect of any unforeseen factors in the environment. Therefore, the fourth logistics principle offered in this article is as much the integration of the previous three as it is an individual concept in its own right.

The environment, though definable in multiple terms, does have basic characteristics of interest to military leaders. Though the physical aspects of the environment, terrain, size of the enemy force, and supply requirements, to name a few, tend to garner the bulk of a military leader's attention and accordingly are addressed by his strategy, tactics, and logistics plans, the intangible aspects of the environment are just as important. Napoleon had a fairly good grasp of the tangible environmental factors that he would encounter during his invasion into Russia. What he failed to consider was the intangible factors that dramatically altered the effect of the physical factors of the environment. The Russian willingness to trade land for time resulted in Napoleon's advancing farther into the interior of Russia without garnering a victory. The Russian willingness to surrender their capital without a major conflict resulted in Napoleon's having to press even farther into Russia in search of an enemy to defeat. These two intangible factors resulted in Napoleon's having to completely change his concept of how he was going to defeat the enemy. Furthermore, Napoleon's logistics plan was not developed to support a seek-and-destroy mission across the vastness of the barren Russian countryside. Had Napoleon understood Russian resolve—that is to say, understood the intangible aspects of the environment of a war with Russia and integrated proper control, flexibility, and technology into his logistics plans—the outcome of the Moscow campaign could have been dramatically different.

Alexander was attuned to the environment he encountered during his campaign against Darius. His goal of *homonia* for all people had no hope of being achieved unless he could bring the conquered peoples under his control. Alexander knew that he would not maintain lasting control if he relied upon military force alone to keep his newly acquired territories in line. He, therefore, allowed them a large measure of autonomy with regards to their own civil affairs. Interestingly, Alexander was viewed as a liberator in some of the areas that he conquered since life under Alexander was viewed as better than life under the rule of Darius. Alexander was able to exploit his understanding of the environment to gain support from the local population. He successfully integrated his control policies, flexibility, and technology into a plan that exploited the support of the local environment and could be adapted to any adverse factors that arose from the environment. Alexander would gladly accept support from the local population, but should they choose not to support him, he was more than capable of adapting and taking whatever he needed by force.

Sherman, too, was well attuned to the environment. In fact, one of his overarching goals was to affect the environment of the people he encountered. Sherman, from the planning stages of the Atlanta campaign, was clear in expressing his willingness to acquire whatever was needed from the local population if the need should arise. This would serve the twofold purpose of meeting his logistics requirements while further supporting his goal of bringing the war to the people of the South. Sherman, by understanding his environment, was able to integrate control polices, flexibility, and technology into his logistics plan, which not only limited the effect of adverse environmental factors but also promoted one of his ultimate goals.

Modern military leaders face an environment that is extremely complex and consistently changing. Major political events in recent history have significantly changed the political, social, and economic landscape of the world. The potential theaters of operations are now, more than any other time in history, more diverse and geographically separated. Given that, it is impossible to understand every possible environmental factor, both tangible and intangible, that may present a logistics challenge. However, by knowing as much as possible about the people, geography, and culture of many areas and developing logistics plans and practices that integrate proper control, flexibility, and technology, the effect of unforeseen and adverse environmental factors can be minimized.

Other Views on Logistics Principles

The four logistics principles put forth by this article—Centralized Control/Decentralized Execution, Flexibility, Proper Application of Technology, and Understanding the Environment—can be found in some form or another in other research. However, it is how this article applies these principles that is quite different from previous research. These principles are not simply a listing of specific *dos* and *don'ts*, they are intended to form a paradigm or framework of thought from which military leaders can draw to develop their own policies and practices. The biggest failing of a list of *dos* and *don'ts* is that it cannot hope to fit every possible situation and, in fact, may be the worst possible course of action for a given environment or situation. The paradigm consisting of the four principles of logistics is intended to guide thought, not specify actions. It facilitates creativity while offering a bounded framework for the development of executable logistics plans. A comparison of Huston's and Thompson's principles of logistics with the four principles of logistics outlined in this article serves to further illustrate the applicability and adaptability of these principles.

In *The Sinews of War: Army Logistics 1775-1953*, Huston outlines 14 principles of logistics: "First with the Most, Equivalence, Materiel Precedence, Economy, Dispersion, Flexibility, Feasibility, Civilian Responsibility, Continuity, Timing, Unity of Command, Forward Impetus, Information, Relativity."[43] It is clear that Huston's principles are intended to be a list of things to do vice a description of how to approach logistics challenges, the latter being the focus of this article's principles. Similarly, Thompson makes use of the *British Principles of Administration* as a reference for general logistics principles in his book *The Lifeblood of War: Logistics in Armed Conflict*. Thompson's principles—foresight, economy, flexibility, simplicity, cooperation—are fewer and broader in scope than Huston's but still, to a large extent, focus on what to do rather than how to think.[44] If viewed on a continuum with the right being the pragmatic *how to* and the left being the thought-provoking paradigm, Huston's principles would be on the far right, Thompson's somewhere between the middle and the right, and this article's principles would be past the middle and more toward the far left. There is no particular spot on the continuum that is particularly better than the other. However, as one moves from the right to the left, the focus becomes more broad, but the principles' applicability also increases to a larger number of situations. Admittedly, moving to the extreme left of the continuum is of little use because the principles would be so broad that, although they would surely apply to any situation, they would be of little use. The resultant guidance would be broad, with useless principles like *employ sound logistics principles* at all times and *ensure your logistics requirements are met*. Generally, an extreme point on a continuum is of little use. The principles put forth in this article, though less pragmatic than the traditional listing of *dos* and *don'ts*, are still specific enough to provide guidance while enhancing applicability by focusing on outlining a way to think instead of listing specific actions to complete.

Application of the Logistics Paradigm

Operational level commanders should, at the onset, endeavor to understand as much about their theater of operations as possible. Studying history, combined with genuine intellectual curiosity, will go a long way in gaining an understanding of a diverse and often multicultural theater of operations. As the perception of the operational environment becomes more clear, commanders, with the aid of their functional experts, can begin to modify their existing command structure, protocols, and organization to facilitate the proper balance between centralized control and decentralized execution. Certain tangible and intangible environmental factors will lend themselves to either a more centralized control structure or a more decentralized one. For example, a geographically vast theater of operations with diverse climates and terrain lends itself to a decentralized control structure. Therefore, the logistics policies and practices within that theater of operations should support a high level of autonomy between distinct, geographically separate units.

Much in the same manner that the logistics command and control structure should be tailored to the specific theater of operations, so should the application of technology. Advanced technology should not be forced into use in an environment in which it is not well suited. Advanced technology should not be the *square peg* forced into an inappropriate situation's *round hole*. Commanders should use the most advanced technology available that is suited for the theater of operations.

For example, no matter how advanced the available motorized transportation is, if the only means of transport through a mountainous area of operations is by donkey, then donkeys should be used. It would be of greater benefit to ensure the best donkeys and donkey drivers are used than to force the use of motorized vehicles in an unsuitable environment.

The fine tuning of control practices and technology to best mesh with the environment within the theater of operations is an iterative process. As more information is obtained about both the tangible and intangible factors of the environment, adaptations to existing policies and practices will need to be made. As stated earlier, a major role of logistics is the neutralization of adverse environmental factors and the exploitation of favorable ones. As a better understanding of the environment is gained, policies and practices must be modified to best take advantage of new opportunities or defend against previously unknown adverse conditions. The discovery of a previously unknown water source could result in a change of logistics policy by allowing the practice of drinking locally acquired, fresh water. Similarly, the discovery that a local water source is no longer potable may result in changing logistics policy and banning of the use of any water found in the local area.

An excellent measure of the soundness of existing logistics policies or practices is the speed with which they can be adapted to meet changes in the environment. The speed of change is a direct function of the flexibility of the existing logistics system. It is, therefore, of paramount concern that flexibility be a core characteristic of any logistics plan, policy, or practice. Reliance upon single sources of supply, the belief there is only one way to do something, and resistance to new ideas are key indicators of a lack of flexibility. Without flexibility, the ability to adapt slows, which, in turn, can result in an excellent logistics plan evolving into a dated, useless way of doing things. The highest degree of flexibility should be maintained in all aspects of an operation. By maintaining the highest level of flexibility, the unit's logistics policies and practices will be able to rapidly adapt to a constantly changing environment.

The previous description of how the logistics paradigm should be applied illustrates the pronounced difference between its application and the use of more traditional, list-type logistics principles. Fundamental to the logistics paradigm is its iterative and adaptive nature. It is meant to guide thought instead of specifying specific actions to take. The shortfall of any list of *to dos* is that there will always be some instance where they do not fit, are inadequate, or are the wrong thing to do. The logistics paradigm focuses on integrating logistics policies and practices with the environment in order to ensure adequate support, exploitation of opportunities, protection against threats, and the ability to adapt to change, all key abilities demonstrated during Alexander's and Sherman's campaigns and woefully lacking in Napoleon's.

Captain Richard A. Hardemon
Logistics Dimensions

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THE LOGISTICS OF WAGING WAR

The End of *Brute Force* Logistics

Introduction

> Any amateur can shove tanks, planes, and infantry around the map; the real business of war is getting gas, ammunition, and spare parts to the people that need them, where they need them . . . the tail, in the form of logistics will more and more wag the dog . . . logistics will increasingly become the single greatest impediment to have real combat capability.
>
> Edgar Ulsamer, *Air Force Magazine,* December 1983

The above quote emphasizes the critical nature of effective logistics to the future employment of military power. Only by studying the lessons of previous military engagements can we improve logistics planning and execution. This document chronicles military logistics efforts from 1982 to 1993.

The first volume presented characteristics of logistics support as the American military grew from militia to worldwide power projection force. The text concludes with a brief commentary on the Falkland Islands war (1982) between Great Britain and Argentina and a forward look at the future of logistics as the United States prepares for operations in the 21st century (1:192).

The scope and nature of military operations conducted during this period and the unparalleled changes wrought by the dissolution of the former Soviet Union and the Warsaw Pact were influential in the evolution of logistics doctrine and practice.

These developments necessitated the publication of this volume to reflect more recent military operations, changes in world affairs, and corresponding changes in the US military as they impact the application of military logistics.

From 1982 to 1993, US military logisticians were challenged by involvement in conflicts centering on Grenada, Panama, and the Persian Gulf. During this period, the geopolitical structure of the world changed markedly. There is little resemblance between the world order that existed at the beginning of the 1980s and that which inaugurated the 1990s. Such drastic changes make it imperative that we seek to understand the military's rapidly changing role in the face of such monumental shifts in global perspective, and the practitioners of the logistics art must seek to understand the lessons of the past.

Operations Desert Shield and Desert Storm and the media attention that accompanied them introduced the US populace in general to the notion of logistics and its importance in modern military conflict. The commander of Operation Desert Storm, General Norman Schwarzkopf, touted the role of logistics in the success of Operations Desert Shield and Desert Storm. Thus, logistics became prominent in the media and part of the public perception of the war.

Logistics played a major role in planning and executing the allied forces war strategy. However the importance of logistics extended beyond the warfighting period. When combat ended, many assumed that once the troops came home, the logistics effort, like the war itself, had ended. Of course, this was far from the case. The allies were faced with not only the need for a substantial retrograde operation to remove equipment from the theater and return it to home base locations but also a substantial reconstitution effort to return equipment and supply stockpiles to necessary readiness levels. The significance of this logistics effort, known as Operation Desert Farewell, is frequently overlooked.

Logistics professionals can ill-afford to squander the lessons learned from involvement in Operation Desert Storm. The conflict severely tasked the majority of US military assets. Until these assets were fully reconstituted, US readiness for future conflicts was degraded. The myopic perspective regarding the extent of the Gulf War logistics effort cannot be allowed to take hold and survive in the heart of the community that can most benefit from the experience—the US military itself.

Every attempt must be made to ensure the logistics community develops a vital understanding of the requirements and critical dimensions of logistics operations. The condition of US warfighting and sustainment assets following Operation Desert Storm directly affects US military readiness for involvement in future conflicts. The importance and difficulties of both combat logistics and retrograde/reconstitution activities should be of substantial interest to US military planners and logisticians.

> . . . [Desert Storm] presages very much the type of conflict we are most likely to confront again in this new era—major regional contingencies against foes well-armed with advanced conventional and nonconventional weaponry . . . We must configure our policies and forces to effectively deter, or quickly defeat, such future threats.
>
> Secretary of Defense Richard B. Cheney, *Defense 91,* April 1991

To the extent that Operation Desert Storm serves as the model for future US military actions, the need to fully understand the depth of logistics involvement in the Gulf War is critical. Maintaining combat capability in the face of a significantly reduced availability of resources is a daunting challenge. Success in this challenge is vital to the maintenance of the US position as the only remaining superpower.

Captain Thomas J. Snyder
Captain Stella T. Smith

Chapter One

Operation Urgent Fury

Grenada

In 1983, the United States led a military operation in Grenada to restore a viable Grenadian government. This operation, Urgent Fury, came about as a response to a request by the Organization of Eastern Caribbean States (OECS). Cuban military units had established fortifications, arms caches, and military communications facilities on Grenada (1:3). The OECS became concerned that the political institutions in place represented a threat to the security of the region.

Objectives

Two key objectives of Urgent Fury were the evacuation of US medical students, along with any others who wanted to leave, and the evacuation of Governor General Sir Paul Scoon.

Logistics Considerations

To meet the objectives for this operation, many different areas of logistics had to be identified and planned. One requirement was to decide how to secure the airport and identify what would be needed to do this. Questions to be answered included how many men would be needed and what type of equipment, ammunition, and support.

The other major requirement was to decide how to locate, protect, and extract the students efficiently. Considerations included the type of airlift, food for the students, and any prisoners of war that might be taken. Answers to the above issues would determine what assets and supplies would be brought to the island. Another logistics challenge was coordinating the roles of the Services. The Air Force, Navy, Army, and Marines all had missions to perform in this operation and had their own logistics problems. The joint nature of this operation required extensive logistics coordination.

US servicemen gather their gear after landing at Port Salines in Grenada. (Official US Air Force photo)

American medical students board a C-141 for evacuation from Grenada. (Official US Navy photo)

During the morning of the first day of the conflict, Army Rangers secured an airfield at Point Salines. This was the only runway that could accommodate a C-141 and was still under construction. A large number of troops and corresponding supplies needed to be brought through the one airfield, but only one large aircraft could be handled at a time. This required an extremely fast turnaround time to unload and get the plane airborne again. During the early part of the operation, ground support would turn around the aircraft within 30 minutes (2:4). The first troops on the scene brought the equipment needed to offload the aircraft that would be following. These people needed to decide where to store the offloaded cargo so it could be accessed when needed without impeding the use of the landing strip.

Constraints

The operation experienced many logistics constraints. Three examples are limited airfield capacity, fuel resources, and potable water.

Getting the necessary supplies to the theater was difficult (3:59). Each service requested strategic airlift directly from

the Military Airlift Command. No single command coordinated and prioritized the airflow based on operational need. Due to limited runway capability, landings were made on a first-come, first-served basis, with the amount of fuel on board dictating an aircraft's status in the queue. Some aircraft carrying essential logistics supplies were diverted to other airfields for refueling, which meant there was a continuous competition for access to the airfield. The lack of a prioritization system meant the same shipment could be bumped multiple times, and there was no way to accurately predict when critical supplies would arrive.

This confusion could have been avoided if existing logistics doctrine had been followed. The existing doctrine would have had all airlift requirements forwarded to the Atlantic Command J-4. Thus, all the requests could have been reviewed and validated prior to going on to the Military Airlift Command. A priority order could have been developed to reschedule less critical flights (3:59).

The air fuel reserves located at Seawall International Airport in Barbados were rapidly depleted by airlift refueling, forcing a change in airlift operations. Maximum allowable cargo payload was reduced from 50,000 to 35,000 pounds to enable aircraft to make the roundtrip from stateside locations without having to refuel (3:59).

The island of Grenada did not have a large supply of potable water. Intelligence received on this logistics issue proved inaccurate. It was initially thought water would be readily available; however, the fresh water supply was low. To complicate the matter, the water system at St. George was rendered inoperable early in the conflict. Water was resupplied by air until desalinization units arrived and were put into operation.

Logistics Successes

The Deployable Mobility Execution System (DMES) was used to support the operation. This portable software application was designed to allow a load planner to process materiel being airlifted to the theater based on its weights and dimensions. The system was intended to save deployment of aircraft by more effectively loading the C-141s being used (4:10). DMES allowed planners to build the most efficient load plans based on lists of equipment and personnel required. In one instance, the planning was accomplished in 20 minutes and saved the use of one aircraft by loading all of the required materiel on four planes instead of the anticipated five aircraft. DMES was used to plan for the airlift of nearly 7,200 short tons of cargo and more than 7,500 troops to Grenada (5:10). The use of this software also allowed planners to quickly change loading plans to accommodate the dynamic priority lists that came from field commanders.

The Forward Area Support Team (FAST) was deployed to support the forces. Since maintenance would be required from the beginning of the operation, the FAST was to coordinate the early maintenance problems and help solve them quickly. They established an operation located at the Salines airfield and set up a facility to collect requests for spare parts from all sources until the Division Material Management Center (DMMC) arrived. The FAST collected the requests and forwarded them to Fort Bragg, North Carolina, via the tactical satellite (TACSAT) or facsimile machine. Once the main body of DMMC personnel set up, all requests went through them so they could use the information available through the TACSAT and rear DMMC to find the most expeditious method of getting the parts (2:6).

Lessons Learned

The issue of joint logistics was not given proper consideration in the planning stage of Operation Urgent Fury. Each Service addressed logistics planning autonomously, which made transferring supplies across Service boundaries a formidable task. There was no single ground commander coordinating logistics efforts, which resulted in a duplication of effort and competition for scarce resources between the individual Services.

Even though Operation Urgent Fury was an overall success, the operation revealed some logistics limitations. This influenced the DoD Reorganization Act of 1986, which placed new emphasis on joint assignments and gave combatant commanders authority in all aspects of logistics. New joint exercise programs were also implemented to improve joint logistics (3:62).

Operation Urgent Fury highlighted the advantages of conducting an operation with bases already located in the theater. The use of a large, secure runway was a tremendous benefit. In addition, the large number of troops already stationed in Grenada and intelligence about the opposition facilitated easier implementation of logistics plans. These factors need to be considered when applying the lessons learned from this operation.

Chapter Two

Operation Just Cause

Panama

> Carl, I've talked to the chief, and I've talked to the chairman, and you are my man for everything that has to be done there. I'm putting you in charge of all forces and you've got it: planning, execution, the whole business. I have looked at my staff, and I have told the chairman and the chief that it cannot run a contingency operation. He said you can have it and I'm holding you responsible (1:55).

General Maxwell Thurman spoke these words to then Lieutenant General Carl Stiner. As a result, a major problem was avoided during Operation Urgent Fury. One of the lessons learned from the military action in Grenada was that a complex, multilayered command and control organization and extremely poor communications between different forces create logistics problems (2:105). General Thurman believed, by putting General Stiner in charge of the entire operation, problems that had plagued Operation Urgent Fury, such as low-priority aircraft landing ahead of high-priority aircraft, would be avoided.

Background

Operation Just Cause was a military action taken by the United States with several objectives: remove General Manuel Noriega from power, protect American lives, restore democracy to Panama, and secure US treaty rights to the Panama Canal. US forces faced many logistics challenges in meeting these objectives. Troops and equipment had to be flown to the theater of operations and set up in secure areas to wait for the operation to begin. Food and medical supplies needed to be sent to maintain the troops. Security guards and locations to keep prisoners of war would have to be in place when needed. Fuel and ammunition to keep the troops working effectively were required.

General Noriega was the head of the Panamanian Defense Forces (PDF) and effectively the dictating ruler of Panama. He had been indicted by two Florida grand juries for involvement with drug cartels (1:21). Noriega was also believed to be the instigator of harassment against Americans and American servicemen stationed in Panama. US servicemen were being stopped and arrested for no obvious or legitimate reason. Some were detained at PDF facilities and harassed. Others had assault rifles aimed at them. Still others were beaten. Tensions continued to escalate, culminating in an incident on 16 December 1989 when Marine Lieutenant Robert Paz was shot and killed by PDF guards at a roadblock. While tensions were high on both sides, the actions of PDF guards provoked a reaction from the White House approving the use of military forces to remove Noriega from power. On 17 December, President Bush ordered the execution of Operation Just Cause. H hour was set for 0100, 20 December 1989 (2:210).

Airlift

The plan for Operation Just Cause called for overwhelming force to attack multiple locations at the same time. US forces hoped the strategy would intimidate the PDF and force them to give up with little resistance. To accomplish this task, the planners spent considerable time figuring out how to secretly move a large number of troops and equipment in a short time. The Military Airlift Command did just that. Headquarters MAC decided it would need 60 hours to prepare the crew force needed for the invasion, including 36 hours to locate the crews and get them assembled and 24 hours for mission planning, preparation, and flight time (3:195). In the first hours of the operation, MAC airlifted 3,500 Army Rangers and paratroopers, along with their cargo, to three separate combat zones. This required the use of 63 C-141s and 21 C-130s (4:42).

Also participating in the airlift were the Air National Guard (ANG) and the Air Force Reserve (AFRES). MAC deployed 111 aircraft from 24 units, while the ANG and AFRes provided

Loading a jeep on a MAC aircraft for transport to Panama. (Official US Air Force photo)

reserve support from 18 units. The Air National Guard provided both strategic and tactical airlift support on C-5s, C-141s, and C-130s. The total number airlifted on the night of the invasion was10,000 combat troops. Six thousand troops landed for deployment, while 4,000 parachuted to prescribed sites. These troops were in addition to the 13,000 troops assigned to duty in Panama at various US installations. The aircraft took off from several bases in the United States and flew at low altitudes to avoid exposure to Cuban radar. Panama was considered a secure area for air operations, with threats limited to ground fire. Only 14 aircraft reported damage, the majority from small arms fire. No aircraft were lost during the airlift mission. The final success of the operation can be attributed to the effectiveness of the airlift in deploying troops and equipment in such rapid fashion (2:115-117).

MAC employed 84 aircraft in the initial operation for airdrop operations. These planes had to fly in from the United States, converge on one of two drop zones about 100 kilometers apart, and drop their loads while avoiding detection by Cuba or the PDF. All of this was happening around 1 a.m. Panama time. The operation was the largest night combat drop since World War II D-day (5:30). To make all of this happen, refueling plans were needed. Since C-130s could not be refueled in flight, they had to land at one of the US-secured airfields to refuel. Additionally, Strategic Air Command (SAC) provided KC-135 and KC-10 tankers to refuel C-141s and C-5s moving troops and equipment into the theater. These tankers came from 26 squadrons located at 14 bases in the United States (2:75-77).

Weather

Weather posed some problems at several locations providing airlift support. Fog at Travis AFB, California, caused the 7th Light Infantry Division to board at Monterey Airport instead of Travis (5:31). On the other coast, an ice storm at Pope AFB, North Carolina, caused a delay in the departure of paratroopers from Fort Bragg. The key to aircraft leaving Pope was the preparedness of the Army Materiel Command's Logistics Assistance Office (LAO). The LAO provided 321 barrels of deicing fluid needed to prepare the aircraft for flight (6:6). However, the delay in meeting the logistics challenges may have been responsible for the eventual interception of these C-141s by Cuban MiGs. Since these planes arrived well after the assigned starting time, the Cubans may have been alerted and were watching inbound routes more closely for air traffic. Several MiGs were launched from Cuba but fortunately did not impact the completion of the C-141's mission (2:91).

Air Superiority

Aside from the encounter with the Cuban MiGs, the United States had uncontested air superiority, primarily because the PDF did not have any fighter aircraft, and no military aircraft were permanently stationed at Rio Hato, the Panamanian Defense Forces installation on the southern coast (7:32). This allowed MAC to drop troops exactly where US commanders wanted them and permitted Air Force and Army aviation to provide close air support as needed. Ground forces operated without fear of enemy air attacks, and resupply by air was uninterrupted (2:67).

Special Operations

Special operations aircraft had a significant role in Operation Just Cause, with 65 helicopters and 20 fixed-wing special operations aircraft providing support on the first night. This amounted to the largest single employment of special operations aircraft in US history. The helicopters transported troops to their assigned positions and suppressed enemy ground fire. The AC-130 gunships attacked the PDF installation at Rio Hato and gave ground support by suppressing enemy ground fire (2:118-120).

Depot Support

To process the required personnel and equipment for deployment, logisticians were assigned to arrival-departure airfield control groups (ADACG). They developed the plans used to load the equipment for airdrop or delivery to Panama. Equipment had to be palletized, weighed, measured, and inspected to meet safety requirements and load restrictions of the aircraft. Support personnel at the depots worked 24-hour shifts to fill requisitions. The Defense Personnel Support Center (DPSC) in Philadelphia, Pennsylvania, processed 95 percent of the supply requirements of the Defense Logistics Agency (DLA), including more than $13.3 million worth of food, clothing, and medical supplies. The Defense Fuel Supply Center (DFSC) in Cameron Station, Virginia, arranged for 1 million extra gallons of JP-4 aircraft fuel to go to Barksdale AFB, Louisiana, and delivered 185,000 barrels of JP-5 fuel to Defense Fuel Supply Point Rodman. Defense Construction Supply Center (DCSC), Columbus, Ohio, supplied spare parts for the Black Hawk helicopter; 5-ton trucks; and high-mobility, multipurpose, wheeled vehicles. At Defense Depot Mechanicsburg, Pennsylvania, more than 1,328,500 pounds of materiel were put together for airlift to Panama. Many other depots and centers supplied tons of materiel in support of the operation (8:2-4).

A major debate for logisticians during any conflict is whether to push parts and other supplies or wait until they are requested. The logistics assistance offices for the Army Materiel Command worked out a compromise. Packages of parts and ammunition were offered to the task force to help streamline the process. The LAO also helped find available seats for defense contractor civilians deployed to Panama. With the limited passenger seats on the aircraft, civilians were strictly controlled.

Problems

The logistics system did not operate without problems. There was no in-transit visibility of ultimate destination of shipments causing confusion at the ports of debarkation and embarkation.

Pallets did not have adequate marking and the data sheets associated with them needed to quickly determine the contents and destinations (6:7-8). These problems occurred from a lack of complete directives given to the personnel who assembled the pallets. The difficulty in efficiently moving supplies illustrated the need for in-transit visibility and complete identification of palletized resources.

Theater Support

The 193[d] Support Battalion provided in-theater logistics support for more than 25,000 troops deployed to Panama. The 193[d] established distribution centers at Luzon Field, Fort Clayton, and in Panama. After the first 6 days of conflict, the battalion distributed 321 short tons of various classes (I-IX) of materiel, including 25 short tons of water. Eighty-five percent of the tonnage went by CH-47 helicopters. They also operated two refueling points that pumped out approximately 110,000 gallons of fuel in the initial 8 days. Alpha Company established an ammunition transfer point and graves registration point. The battalion's 1097[th] Transportation Company supported missions by transporting 2,442 passengers, 848 prisoners, and 738 short tons of cargo. Much of this support was provided under enemy fire (9:8).

In support of the overall operation, the Military Airlift Command flew 775 missions to transport 39,994 passengers and 20,675 tons of cargo, approximately one-half ton of cargo for each person deployed during the operation. The special operations units added an additional 796 missions neutralizing PDF resistance. Eight C-5s and fourteen C-141s provided humanitarian airlift efforts intended to provide for families of American troops stationed in Panama as well as Panamanian people displaced by the operation. They transported 3 tons of medical supplies, 10,000 blankets and sheets, several tons of baby food and food staples, and 2 million field rations. After the first day's operations, MAC aircraft were used to deploy 2,500 troops for security. Return trips to the United States were used to evacuate wounded service personnel, along with materiel no longer needed in the theater. The wounded were brought to Kelly AFB, Texas. Two hundred and fifty-seven patients were flown aboard one C-130 and eight C-141s (3:197-8).

Medical

The medical logistics mission was to provide materiel to care for casualties and ease suffering. Medical logisticians had to know the size, location, and duration of casualty flow to determine the scope of support needed. Fortunately, adequate medical inventories were already positioned in US medical treatment facilities located on the US military bases in Panama. Medical supplies were airlifted to Howard AFB, Panama, to be distributed from there. The medical logistics experts in Panama were not given information about the conflict prior to its occurrence and, therefore, implemented the medical logistics plan given to them after H hour. The plan called for Joint Casualty Collection Point (JCCP) personnel to bring adequate supplies and equipment stocks with them as they

A wounded US serviceman is loaded for transport to a medical facility. (Official US Air Force photo)

deployed. Resupply then came from the continental United States (CONUS) pipelines which caused a shortage of routine items such as litters, blood expansion fluids, sterile gauze, and other items.

Restocking supplies came from the Emergency Supply Operations Center (ESOC) at the DPSC in Philadelphia, Pennsylvania. Requests were made by AUTOVON and fax to Wilford Hall Medical Center, Lackland AFB, Texas. Medical logistics personnel pulled, packed, palletized, and loaded the requested materiel for delivery within 24 hours of the request. The Medical Logistics (MEDLOG) system, an automated supply and equipment inventory transactions system, was available on the computer systems but only after a secure, uninterruptable power supply was established (10:2-5).

Additional medical logistics were handled using the Theater Army Medical Management Information System for Medical Supply (TAMMIS-MEDSUP), a computer software program that automates combat patient records, tracks blood inventories, and manages other medical logistics data (8:5).

The F-117 was first used in combat during Operation Just Cause. (Official US Air Force photo)

F-117

The Panama attack was the first combat mission for the F-117A fighter. This aircraft was designed to penetrate radar and air defenses and perform single-aircraft attacks on high-priority targets deep behind enemy lines (7:32).

The F-117s were to drop two 2,000-pound bombs near a PDF barracks at Rio Hato to stun the PDF into giving up without a fight. The F-117 was used because of the needed accuracy of the bomb drops. The aim was not to hit the PDF but to scare them enough to give up. Six F-117s were flown to Panama to drop the bombs or to support other missions if needed and then returned to the United States without landing. Refueling in flight was required for these aircraft (7:32-33; 11:30).

Enemy Assets

Another logistics issue that arose during the operation was handling enemy assets. One large category of confiscated items was weapons and ammunition. Combat service support soldiers had to inspect, classify, and transport more than 700 tons of ordnance, including more than 50,000 weapons captured from the Panamanians. They also had to manage other confiscated equipment. They sorted, classified, cataloged, and packaged 31 aircraft, 29 armored vehicles, 7 patrol boats, and 20 antiaircraft guns. Decisions about disposition of the items were made based on potential use. If the item could be used by US troops in theater, it was forwarded to a unit that could best make use of it. Otherwise, all materiel was packed and removed from the theater (8: 5).

Lessons Learned

The overall success of Operation Just Cause can be attributed to many things. The efficient nighttime airlift, along with detailed planning and effective air traffic control, were critical. Effective training missions by all of the forces prior to the conflict, especially those already in Panama, enabled logistics requirements to be defined prior to the operation. Having 13,000 troops already stationed there and familiar with the surroundings was a tremendous benefit. Some of these troops were airlifted by MAC 11-18 May 1989, prior to the start of the operation. A total of 5,915 soldiers and marines and 2,950 tons of cargo were sent to Panama during this time period on 34 C-5, 39 C-141, and 2 commercial L-1011 missions (3:195). The fact that the PDF did not have an air force to speak of is yet another reason for the success of the missions. All of these facts need to be remembered in considering the overall success and lessons learned from Operation Just Cause.

Chapter Three

The War in the Persian Gulf

Overview

On 2 August 1990, Iraqi forces, under the command of Iraqi president Saddam Hussein, launched an all-out invasion of the neighboring country of Kuwait. At 0100 local time, divisions of the Iraqi Republican Guards crossed the Iraq-Kuwait border on two separate axes, moving rapidly southward toward Kuwait City in a classic blitzkrieg operation. The initial assault was coordinated with direct special forces attacks on Kuwait City and helicopter and amphibious assaults at key points of tactical significance. The war in the Persian Gulf had begun.

US troops board a military transport aircraft for deployment to Southwest Asia. Most troops would deploy via Civil Reserve Air Fleet aircraft vice military aircraft. (Official US Air Force photo)

When US forces were ordered to deploy to the Persian Gulf in August 1990, the challenges confronting logisticians were unparalleled since World War II. A force exceeding that deployed in either Korea or Vietnam would be deployed half a world away over an exceedingly short span of time. The logistics pipeline supporting the theater would span more than 8,500 nautical miles over an indirect, 17-hour flight from the United States to the Middle East via Europe (1:17-18).

Operations Desert Shield and Desert Storm involved the largest contingency deployment of troops, supplies, and equipment ever undertaken by the US military. Commencing on 7 August 1990, Operation Desert Shield set in motion the opening deployment of US forces with elements of the 1st Tactical Fighter Wing from Langley AFB, Virginia, flying F-15Cs, initiating US forward presence in the crisis area. The primary intention of Desert Shield was to protect Saudi Arabia and US interests from the threat of expansion of Iraqi offensive operations beyond the borders of the now occupied Kuwait. Operation Desert Storm would subsequently commence on 17 January 1991, with the unleashing of a massive, unparalleled airborne campaign, assaulting key Iraqi forces and installations with the eventual aim of forcing the complete withdrawal of Iraqi forces from Kuwaiti territory. The ground phase of operations began on 24 February 1991 and ended exactly 100 hours later in an Iraqi rout.

The scope of the logistics effort necessary to accomplish a coalition victory in the Gulf War was massive. The US military moved a previously unprecedented volume of personnel and materiel across great distances to a geographically remote theater of operations and successfully employed these forces in the execution of a major military campaign. For the US military and, indeed, US foreign policy in general, there were many lessons and implications stemming from the many logistics successes. Recognition of shortcomings and obstacles encountered in both defensive and offensive operations also provides critical insight toward the conduct of future theater-specific crisis military actions. The exceptionally massive effort needed to equip, transport, receive, employ, and sustain a force in excess of 500,000 US military personnel in the face of the geographic distance of the combat theater; the extraordinarily harsh environment in which personnel and equipment were required to operate; and the absence of any preexisting US military forward presence or basing agreement contributed significantly to the creation of a logistics challenge of phenomenal proportions.

Unique Challenges

Operations Desert Shield and Desert Storm confronted the US military with many complex and wholly unexpected logistics challenges. For example, US Marines found themselves operating well inland with a line of supply stretching from the port of Al Jubail in Saudi Arabia, 250 miles across the desert, to Kuwait City. Army units also faced a long line of supply that resulted in a shortage of transportation equipment—trucks, trailers, vans, buses, forklifts, and other special purpose vehicles. This situation was exacerbated by the continual arrival of additional units. Eventually, shortfalls were alleviated through contracted host nation, commercial support and the arrival of additional transportation assets from the United States. This heavy demand for vehicles and transportation capability, coupled with the extremely harsh climatic conditions in which equipment was operated, led to a higher than expected load on the forward supply system. Air Force units similarly discovered their demand for consumable items—such as oil filters, tires, and batteries—was much elevated over levels planned prior to deployment.

During the 43 days encompassing Operation Desert Storm, Air Force fighter aircraft logged 34,038 sorties and in excess of 118,000 aggregate flying hours. There were 45,666 sorties flown transporting personnel, supplies, and equipment within the theater of operations,and 17,331 strategic airlift missions. Such high-utilization levels generated a commensurate demand for repair items and consumables.

Another unique aspect of Operations Desert Shield and Desert Storm with a significant effect on logistics operations was the employment of certain equipment and weapons systems in roles and missions different from those for which the systems were originally designed. One of the more famous systems participating in the conflict and employed by the Army, the Patriot missile system, was designed to accommodate the threat of high-performance aircraft and certain missile systems with nonballistic trajectories. The system gained notoriety, however, in its exclusive use, with marked success, against Iraqi Scud missiles.

Patriot missile just after launch. This weapon system was successfully used to intercept Scud missiles launched from Iraq. (Official US Air Force photo)

US personnel discussing support with Saudi military commanders. (Official US Air Force photo)

The Patriot system was also involved in the first deployment of US ground forces on Israeli soil as a part of Patriot batteries set up outside Tel Aviv. Similarly, the A-10 found itself servicing an expanded role beyond close air support by providing active battlefield air interdiction prior to the commencement of the US ground assault.

Still another unusual aspect of Desert Shield and Desert Storm operations stemmed from the unique social and cultural environment existing in Saudi Arabia, into which US personnel were deployed.

For the Department of Defense, the challenge was not only to keep the troops in the field equipped and supplied, a daunting task in and of itself, but also to do so within a framework of strict local customs stemming from the traditions and tenets of the Islamic faith. Some items, such as alcohol and non-Islamic religious items, were banned outright by the Saudi Arabian government. Strict mores regarding materials that Saudi censors deemed pornographic kept such items as *Sports Illustrated's* annual swimsuit issue, sent to servicemen by a well-meaning American public, out of the hands of US troops. In a similar vein, Saudi Arabian social beliefs regarding the role and place of women in society created a challenging environment for the thousands of US servicewomen deployed in defense of a country that does not itself allow women to serve in its military in any capacity. These issues impacted the choices made in the execution of plans for the region. It also forced logisticians in general to be very flexible in adapting to unforeseen restrictions imposed by local custom.

Volume of Requirements

By the end of the ground war in late March 1991, US transportation forces accomplished the equivalent of moving all the people, vehicles, and household goods of Oklahoma City halfway around the world to the Persian Gulf. That included about 547,000 passengers, approximately 2.9 million tons of equipment, 6.5 million tons of refined petroleum products, and nearly 1 million tons of supplies (2:41). This population was fed, housed, clothed, protected and entertained. There were 400,000 personnel eating three meals

a day, 7 days a week, amounting to 1,200,000 meals per day or 8.4 million meals per week. While the Saudi government supplied vast quantities of soft drinks, fresh fruit, and potable water, the requirements on the US logistics system were immense from the start (1:19).

During the first 10 days after the announcement of Operation Desert Shield, the Naval Supply Center at Norfolk, Virginia, requisitioned almost 5 million pounds of subsistence for deploying ships from the Defense Depot, Richmond, Virginia (DDRV). More than 120 truckloads were required to support the requisition. This represented only a percentage of the Naval Supply Center's total requisitioned requirement supported by the Richmond depot (1:18). This surge in depot activity was representative of the massive total logistics effort required.

During a 5-day period, 250 18-wheel tractor trailers full of equipment for deploying US Army units inundated Fort Stewart, Georgia. Another 128 truckloads of ammunition were also delivered. The port of Savannah, Georgia, was likewise deluged with an influx of armored, support, and other vehicle types as units prepared for their deployment (3:10).

In the first 30 days of Operation Desert Shield, New Cumberland Army Depot, Pennsylvania, shipped more than 3,000 tons of repair parts, tool sets, and construction materials to Saudi Arabia via the Port of Baltimore, Maryland, and Dover AFB, Delaware. In contrast to the traditional European war scenario, where basic stockage items are already prepositioned in the theater, Desert Shield involved sending troops to a theater with a minimal in-place infrastructure (3:11). The Army's Military Traffic Management Command (MTMC) routed more than 83,000 passengers, 27,360 trucks, and 15,827 rail cars to stateside ports (2:41).

During the first 30 days of Desert Shield, Army depots throughout the United States shipped more than 45,000 tons of support materiel to the Middle East. Another 6,000 tons of supplies were prepared for shipment and awaiting transport. According to AMC officials, the initial loads included more than 30,000 tons of ammunition and explosives, 6,000 tons of major end items such as tanks and howitzers, and 6,000 tons of repair parts. Another 3,000 tons consisted of clothing, construction and barrier materials, and medical supplies (3:11).

To comprehend the need for such a significant level of depot-type supply activity, one must realize a modern military force operating in an austere theater generates a significant logistics *tail* in the form of its ongoing sustainment requirements. A typical armored division—with some 350 tanks, 200 Bradley fighting vehicles, and 16,000 soldiers—may consume, on a daily basis, 5,000 tons of ammunition, 555,000 gallons of fuel, 300,000 gallons of water, and 80,000 meals. In addition to the division's fighting vehicles, nearly 1,000 cargo, fuel and ammunition trucks are required. Typically, the M1A1 main battle tank consumes between 6 and 7 gallons of fuel per mile. An armored division can go 3 to 5 days without external resupply; about 3,500 of its troops—or about one-quarter of the division—will have logistics responsibilities of some kind (4:21).

Trucks and tanks assembled at a US port prior to being loaded onto transport ships. (Official US Air Force photo)

Desert Environment

The climates of Iraq and Saudi Arabia are determined by two of the great *weather engines* of Asia—the Great Indian Heat low-pressure system year-round and fast-moving Arctic cold fronts from the Commonwealth of Independent States in the winter.

From May through November, climatic conditions in the theater of operations were typified by high temperatures and a dust haze of varying intensity up to an altitude of several thousand feet. While the ever-present dust creates problems for personnel and equipment alike, the chief hazards to military operations in the region in the summer months were towering mile-and-a-half high sandstorms—great rolling walls of red sand and dust propelled by gale force winds (5:36). Average noonday temperatures above 110 degrees take a significant toll on personnel and equipment (6:15).

December marks the start of the rainy season in the theater. Rainis present intermittently until about April when summertime conditions again begins to emerge. The rainy season is dominated by the presence of fast-moving Arctic fronts that cause considerable wind shear and extremely variable weather conditions. Friendly air operations throughout northern Saudi Arabia and Iraq were hampered by extended periods of fog, low ceilings, clouds, and rain. When conditions at friendly airfields were able to support aircraft sorties, conditions at the target often obscured objectives and limited or eliminated both combat and reconnaissance opportunities (5:36).

The desert environment with its fine, blowing sand and harsh temperatures is hard on man and machines. The demand for air filters, vehicles, and aircraft surpassed all expectations as did the need for more frequent maintenance. Orders for oil filters and the variety of lubricants required to maintain a substantial mechanized force also exceeded expected demands. One newspaper quoted Army officials:

> The harsh environment and accelerated training pace is wearing out our parts much more quickly than expected.

For example, most filters fail eight times faster; tires, five times. In general, the Army, based on past testing in desert conditions, has been buying parts three and a half times its normal rate for systems deployed in the region and it's proven to be pretty accurate. (1:19)

Due to the dust, the time between overhauls of some Chinook helicopters fell from an average of 300 or more flying hours to about 50 due to dust. The combination of more sorties and fewer maintenance opportunities caused the asphalt-like paving surfaces on several of the flight decks of US aircraft carriers stationed in the region to wear thin prematurely (7:2). Also, high temperatures rapidly drained batteries and blew electric circuits. Hoses and pumps were found to have an equally limited life in the desert environment. Resupplying these less glamorous but absolutely essential items made up a substantial portion of the demand on defense depots and often necessitated emergency shipments to get these critical items to the field. As temperatures in the desert began to drop with the passage of the seasons, demands for other items—such as long underwear, sleeping bags, field jackets, and night desert camouflage coats—soon materialized (1:19).

US military aircraft were forced to operate under harsh climatic conditions during the Gulf War. A constant problem was the effect of sand on all major weapon systems. In this photo, a C-130 kicks up a dust cloud while landing. (Official US Air Force photo)

Personnel were also exposed to the effects of the desert environment. Health hazards that particularly worried military health officials were onchocerciasis (*river blindness*); bilharzia; malaria; and, strangely enough, rabies. River blindness is common in this theater and is caused when an individual is bitten by the black fly—an insect smaller than a common housefly that injects its larva into the bloodstream, after which they migrate to the optic nerve and cause irreversible damage. Bilharzia, a form of schistosomiasis, is a liver parasite that annually kills tens of thousands. The flukes of this organism are found in surface waters and are known to penetrate the skin of the feet, legs, and hands and then migrate to the liver where they cause their damage. Two types of malaria, vivax and falciparum, increase during the rainy season. Incidents of rabies also tend to become more prevalent with

US Army airborne troops wearing some of the equipment issued to US forces to protect them from the climatic conditions found in Southwest Asia. Note the goggles and cloth used for eye and face protection. (Official US Air Force photo)

the change of seasons with wild dogs and native fennec foxes serving as carriers (5:38). Under the desert conditions of Southwest Asia, water, sanitation, and food preparation techniques differ greatly from those practiced under a more often exercised defense-of-Europe warfighting scenario. Medical supplies and care must be geared to hot weather and desert peculiar illnesses. The arid climate dictates a supply of specialized equipment: desert camouflage clothing, nets, and flameless ration heaters. Equipment must be tuned and modified to operate more efficiently in the desert.

The threat of chemical and biological warfare by Iraq compelled another set of unique requirements: specialized equipment; chemical agent-resistant paint; mission oriented, protective posture gear; and chemical agent detectors. Because crucial oil stocks are subject to attack, it was necessary to deploy equipment to build and repair pipelines (8:21).

The troops are wearing standard protective chemical/biological equipment. This gear would be donned when the threat of chemical/biological weapons use was present. *(Official US Air Force photo)*

Overseas Deployment Requirements

In addition to the logistics requirements peculiar to a desert setting, there are those required for any overseas deployment: equipment and services for port and airfield operations, personnel and equipment to plan and construct support facilities and depots, and second-destination transportation assets (8:22). Since only limited stocks for the Army were prepositioned in the Middle East, most supply support items had to be shipped through channels originating in the United States and Europe (9:8).

A Complete Team

While the military personnel involved in prosecuting the Gulf War received the bulk of public and media attention, they were only a portion of the total force that made a successful US conclusion to the Gulf War possible. Civilian personnel almost exclusively staff defense depots, and the dedication of the work force was a critical factor in the successful deployment and sustainment of US troops. Another civilian force, the transportation industry, played a key role in the deployment effort (1:18). Industry executives estimated there were about 1,000 contractor personnel at airbases, on aircraft carriers, and at other military facilities throughout the Gulf region. Their primary role was to assist military technicians in diagnosing and solving problems with weapons systems and assessing and repairing battle damage (10:D2). Without significant contributions by government civilians, contractors, and the thousands of people working at plants and factories supplying everything from bottled water and desert camouflage uniforms to spare parts for the Abrahms main battle tank, the ability of the United States to successfully support a major military campaign in the Gulf region would have been jeopardized.

Host Nation Support

Saudi Arabian Support Critical

Regardless of the presence of culturally based restrictions on the activities of deployed US service personnel, Saudi Arabian support for its allies was generally superb and unqualified. As the host for the allied coalition arrayed against Saddam Hussein and his armies, Saudi Arabia provided extensive logistics support in the form of basic supplies such as food, water, and fuel. In addition, many US personnel were billeted in quarters or commercial hotel space provided by the Saudi Arabian government. Such support was usually provided free of charge to the US government. In addition to support provided by Saudi government organizations, many US units actively contracted for commercially available supplies such as tires, batteries, and fuel pumps when these and similar items were not available through available DoD supply channels in a timely manner. Additional services such as transportation, sanitation, and food service were also often contracted from host nation vendors.

Host Nation Facilities

While many US personnel found themselves bedding down in unimproved remote sites and, ultimately, large tent cities erected by deployed US personnel, troops billeted near large Saudi metropolitan areas were often housed in available and modern commercial military or civilian apartment complexes located near or on existing Saudi airbases. Such was the case for many US personnel deployed near Riyadh and King Kalid Military City. Other housing facilities supplied by the government of Saudi Arabia were often in the form of residential camps built to house foreign nationals employed in support of the expansive Saudi Arabian petrochemical industry. Such facilities generally not only improved the quality of life for the personnel housed therein but also provided a ready means to rapidly billet incoming personnel while arrangements were made for their eventual beddown at forward operating locations.

Modern port facilities such as those at Al Jubail, which served as the primary debarkation point and theater supply depot for US Marine Corps forces in theater, provided adequate mooring capacity, warehousing, staging, and aggregation areas. Saudi ports were generally well served by modern highways and were usually only hampered by limitations in the number of large cranes and derricks available for unloading bulk and containerized cargo.

Units of the US Air Force were stationed at several Saudi airbases, many of which were built for contingency purposes and had never been used. Such facilities varied from installations complete with hangars, water and sanitation systems, living quarters, and messing facilities to more austere locations providing only a serviceable runway and little else.

For the forces deployed in support of Operations Desert Shield and Desert Storm, the range of conditions experienced varied from the austere to the luxurious. Logisticians were forced to account for the realities of desert warfare and the possibility of sustained operations in a chemical or biological

Saudi dock laborers are helping berth a US aircraft carrier. Local Saudi nations were employed or supplied by Saudi Arabia to support US forces in a variety of ways. They would also be used to unload and load US and coalition ships. (Official US Air Force photo)

environment. This meant many unique challenges had to be overcome to ensure protection of US personnel and equipment and ultimately provide the coalition victory in the campaign to oust entrenched Iraqi forces from occupied Kuwaiti territory.

Host Nation Contractors

To bolster the small contingent of dedicated logisticians and support personnel initially deployed to the theater, the military turned to local vendors, contracting for billions of dollars worth of rentals, services, and equipment. Because of the urgent need to supply the daily throng of arriving troops, the military initially bypassed normal bidding procedures to purchase items as diverse as rice, Bedouin-style tents, and lumber (7:2).

Heavy construction equipment was used by US forces to perform a variety of tasks in Southwest Asia. (Official US Air Force photo)

During Desert Shield, US military forces were poised for principally defensive military operations. Once President Bush directed US commanders to prepare their forces for possible offensive operations, logistics elements in the theater had to be rapidly expanded to accommodate the influx of up to another 200,000 military personnel. Military construction units expanded aircraft ramps and parking aprons, built maintenance hangars at airfields and ports, and laid roads across on an otherwise trekless desert. Clearing and preparing huge staging areas to hold arriving vehicles, containers, equipment, and supplies effectively doubled port capacities. Traditionally, the *tooth-to-tail* ratio of combat troops to support troops has been roughly 1 to 3. For Desert Storm, the ratio changed to something more like 1 to 5 due to the distances involved and the duration of the operation (7:1).

Military support personnel were fortunate that the legacy of the oil boom left huge amounts of construction equipment and trucks that US forces rented. Many locations needed alteration to accommodate the number and type of aircraft brought by coalition forces. Additionally, the rental of fuel trucks and drivers was instrumental in the sweeping maneuver used by coalition forces in the ground attack against Iraq (11:1).

Multinational Force and Logistics Requirements

The largely multinational force deployed in the theater presented numerous logistics challenges in the areas of interoperability, identification of enemy combat equipment, food, maintenance, transportation, and medical services. Additional concerns included development and testing of equipment for desert warfare, stress-protective measures, desalination, host nation support, mobile power generation, chemical defense and decontamination, and communications for command and control (8:22).

Sealift

Dedicated airlift and fast sealift efforts indicate the US military has some formidable capabilities in meeting its quick mobility needs. However, it took the full-time commitment of 90 percent of the C-5 fleet and 80 percent of the C-141 fleet to transport just 15 percent of the dry cargo moved during this effort. Eighty-five percent of the dry cargo was moved by sealift. Sealift picked up the burden of moving heavy equipment and materiel to the Gulf, but for the most part, it was too slow. Fast sealift was the exception. These oversized, roll-on/roll-off vessels were able to get heavy weapons and equipment to the Gulf in half the time (2 versus 4 weeks) it took conventional vessels, thus were tremendously valuable. In fact, when the first two fast sealift ships arrived in Saudi Arabia, they carried more tonnage than the entire airlift up to that point (12:30).

Other than airlift and fast sealift, moving war supplies by ships was a long and tedious process requiring at least a month or more to complete. Only 12 of the 44 Ready Reserve ships could be activated in the specified 5-day period (13:5). In fact, many of the ships used to accomplish this function were so old it was hard to find crews to operate their steam turbines. In one case, an 80-year-old seaman came out of retirement to help (14:42).

US Navy gray bottom is being used to ferry trucks to the Gulf. This type of ship is normally used as a helicopter carrier. US Navy ships during the Gulf War were pressed into service to perform tasks for which they were not designed. (Official US Air Force photo)

Military vehicles are driven directly into the hull of a transport ship. Sealift is critical to the movement of the heavy equipment that supports all major US ground force elements. (Official US Air Force photo)

Although the US force projection strategy calls for the ability to move out quickly, Desert Shield clearly showed just how many weaknesses the US military has in this area. As General Gray noted, "Our forces must have the ability to get to areas of crisis quickly and by multiple means of deployment" (15:14). The Gulf War demonstrated that the United States currently does not have enough airlift and fast sealift forces to, as Confederate Army General Nathan Bedford Forrest said, "get there the firstust with the mostest," unless it has considerable time to build up (16:50).

One of the clearest lessons of the Gulf War is the United States cannot rely on airlift and fast sealift alone to support its mobility plans. Even though the United States staged the largest airlift of troops and equipment in history, it was still too slow. "If the situation had been slightly different and Iraq had attacked the 82d Airborne soon after deployment, the light rapid deployment forces would have served as little more than a speed bump for the then massed Iraqi Army" (17:2-3).

Despite their superior numbers and armor, the Iraqi forces chose not to attack. Instead, the United States had 6 months to build up and prepare to take the offensive. It is unclear how the US logistics community would have responded if it had been forced to start combat operations in August instead of 6 months later. General Schwarzkopf noted later that in the event of an attack, the only option US forces would have had was to "pull back to an enclave on the coast and hope we could either reinforce them or get them out" (18:310).

The comprehensive mobilization, buildup, and sustainment of this conflict showed the US military has tremendous capabilities—once it gets them in place. However, it lacks the strategic lift resources to mobilize at the speed it would like. It is also unlikely the DoD will get considerably more strategic lift resources to make up for this shortfall. So the question becomes, what can be done to reduce our reliance on strategic lift resources (19)?

Various sources chronicled three major ways the strain on the overburdened lift system was reduced. Prepositioned supplies, highly accurate and reliable weapon systems, and contracts let within the theater all took some strain off strategic airlift and fast sealift.

Airlift

Over the course of the first 5 weeks of Desert Shield, the tactical airpower assembled in the Gulf region—comprising USAF, USN, and USMC squadrons—would exceed more than 400 combat and 250 support aircraft, a

C-5s from the Military Airlift Command were used to transport outsized and oversized cargo to the Gulf. While most heavy unit equipment was moved via sealift, MAC moved heavy equipment to support early deploying units such as the 82^{d} Airborne Division. (Official US Air Force photo)

force roughly equivalent to the force deployed in Europe during the Cold War. Each 24-plane fighter squadron that deployed required the equivalent of 20 C-141 airlift cargo loads of more than 70,000 pounds each to support initial deployment and operating capability (20:19).

During the first 12 days of the deployment, the Military Airlift Command delivered 19,000 tons of cargo to the theater of operations, including three tactical fighter wings and most of the 82^{d} Airborne Division. When Desert Storm ended on 28 February 1991, strategic airlift had conducted approximately 15,800 missions and transported more than 501,000 passengers and 544,000 tons of cargo to the Middle East (21:8). As the network news so aptly illustrated, air assets were extremely limited throughout the deployment. In what became a somewhat routine camera shot of a busy Saudi Arabian flight line, Federal Express and Burlington Air Express were shown side by side with Air Force C-5s and C-141s (1:18).

Figure 1. Major Desert Shield and Desert Storm Aerial Ports of Debarkation

Desert Express

For the majority of items requisitioned by forces deployed in the theater, at least 10 days were required for the order to make its way through the supply system from the United States to the end user in Saudi Arabia. Due to congestion at the aerial ports and the fact that 10 days were too long to wait for mission critical items, a daily Desert Express cargo service was initiated. C-141s operating between Charleston AFB, South Carolina, and eastern Saudi Arabia reduced the time from the moment an order was placed to the time the needed item arrived in Saudi Arabia to as little as 72 hours (22:46).

Figure 2. Major Desert Shield and Desert Storm En Route Locations

Crews scurried onto a nearby parking apron, stripping plastic wrap off pallets and sorting dozens of IBBs and GBBs—*itty bitty boxes and great big boxes*—in the parlance of the unloading teams (22:46). Desert Express could put a package or pallet of high-priority materiel in Saudi Arabia in as little as 16 hours and 15 minutes after takeoff from the United States (23:20). The daily flight did not carry a great deal of tonnage, less than 40,000 pounds per flight. The biggest users of Desert Express were Air Force and Army aviation units (23:20).

Operating from 30 October 1990 to 31 May 1991, Desert Express flew more than 200 missions to the theater of operations (21:26). In addition to Desert Express, on 7 December 1990, US Transportation Command (TRANSCOM)

established the European Desert Express. This daily flight, like its US-based counterpart, provided express service of high-priority cargo from Europe to the Gulf theater. The European Desert Express flew 92 missions before it ended operations on 31 March 1991 (21:26).

Each shipment was carefully monitored to prevent abuse of the priority system. Items being shipped had to meet the criteria for priority treatment; otherwise, they were diverted to the regular airlift stream (23:20). Once airborne, there was only a single, 1-¼-hour stop at a staging base in southern Europe. Upon arrival, Desert Express aircraft weent to the head of the service queue while the aircraft's crew was swapped out with fresh personnel. A second aircrew and a backup aircraft were kept standing by in the event of a problem that would otherwise delay the mission. As few as 15 minutes were required to shift palletized loads from one aircraft to another (23:20).

Reliability of military airlifters averaged about 85 percent for the C-5 and 91 percent for the C-141 through November 1990. The only chronic problems peculiar to Desert Shield were excessive stress on main landing gear struts associated with the heavy loads and sand working its way into seals. Sand abrasion on the strut's piston caused the seals to wear out prematurely, requiring repacking at staging bases on an accelerated schedule (23:21).

Intratheater Airlift

Once in the theater, Desert Express materials were quickly transferred to the seven C-130s designated to fly short-haul Camel Express (cargo) or Star Route (personnel) flights to the various bases in the Persian Gulf Region (23:22).

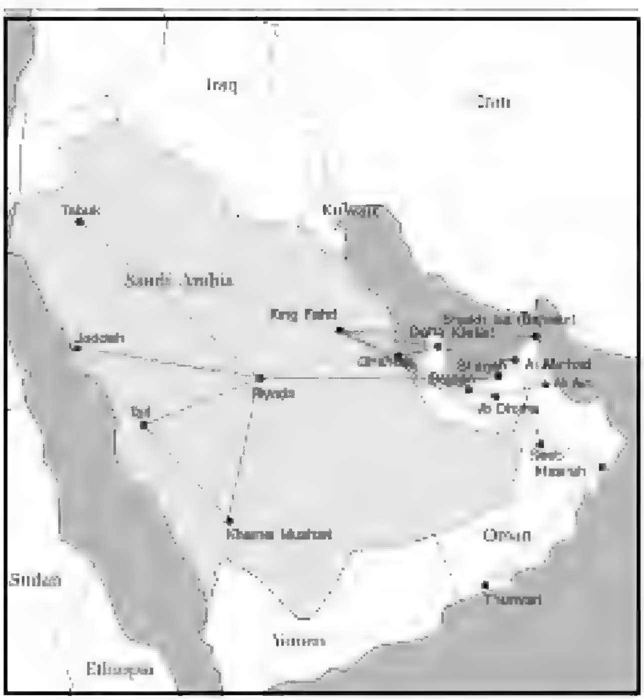


Figure 3. Intratheater C-130 Camel Routes (27:9)

Cargo arriving in theater was broken down and distributed to holding areas maintained by each of the Services. Incoming personnel were likewise directed to one of three *circus tents* for processing and transportation to their units (23:22).

Although several thousand C-141 sortie equivalent loads were transported to the area of operations, much of the equipment was centrally stored and not efficiently distributed to its final destination (9:8).

APOE

The demand for air shipment direct to Saudi Arabia grew as more units arrived in the theater. Aerial ports of embarkation (APOE)—such as Dover AFB, Delaware; McGuire AFB, New Jersey; and Charleston AFB, South Carolina—soon approached gridlock. Each Service operated an airlift clearance authority (ACA) to control its respective Service allocation of theater bound military airlift. Shipments from the depots were forwarded to the designated APOE for entry into the allocation and prioritization system. Because of the overwhelming volume of air-eligible shipments, TRANSCOM established a fixed set of prioritization criteria to expedite the decision process. These criteria automatically downgraded a large volume of shipments to surface (sealift) mode (1:20).

By October, the situation at the APOE, while somewhat improved, still found the APOE overwhelmed by more tonnage than they possibly could move quickly on available aircraft. Critical repair parts were not getting shipped quickly enough. Desert Express helped bypass the regular APOE backlogs. Each service was allocated space for "the highest priority, not-mission-capable supply" (NMCS) items. Desert Express freight was restricted to repair parts and medical items only (1:20).

Constraints

Several factors that adversely affected airlift operations were identified in a General Accounting Office study published in the aftermath of the Gulf War. These factors included the limited number of locations initially available in the theater of operations for strategic airlifters to unload cargo, the general failure on the part of the Services to regulate their requisitions for high-priority airlift, insufficient cargo airlift capability to meet Central Command's requirements for sustainment cargo, and Central Command's constant and rapid shifts in airlift priorities (21:18).

During Desert Shield and Desert Storm, there was a high incidence of poor discipline in the assignment of priority codes to nonpriority cargo. Cargo coded *999* is recognized as the highest movement priority and is intended to consist of items such as medical supplies, critical spare parts, or other items that might seriously degrade the mission if not delivered quickly. However, on numerous occasions, the *999* code was assigned to large volumes of inappropriate items. As a result, the volume of high-priority items being placed in the airlift system overstressed the system's ability to accommodate the number of requests. As more and more priority-coded cargo

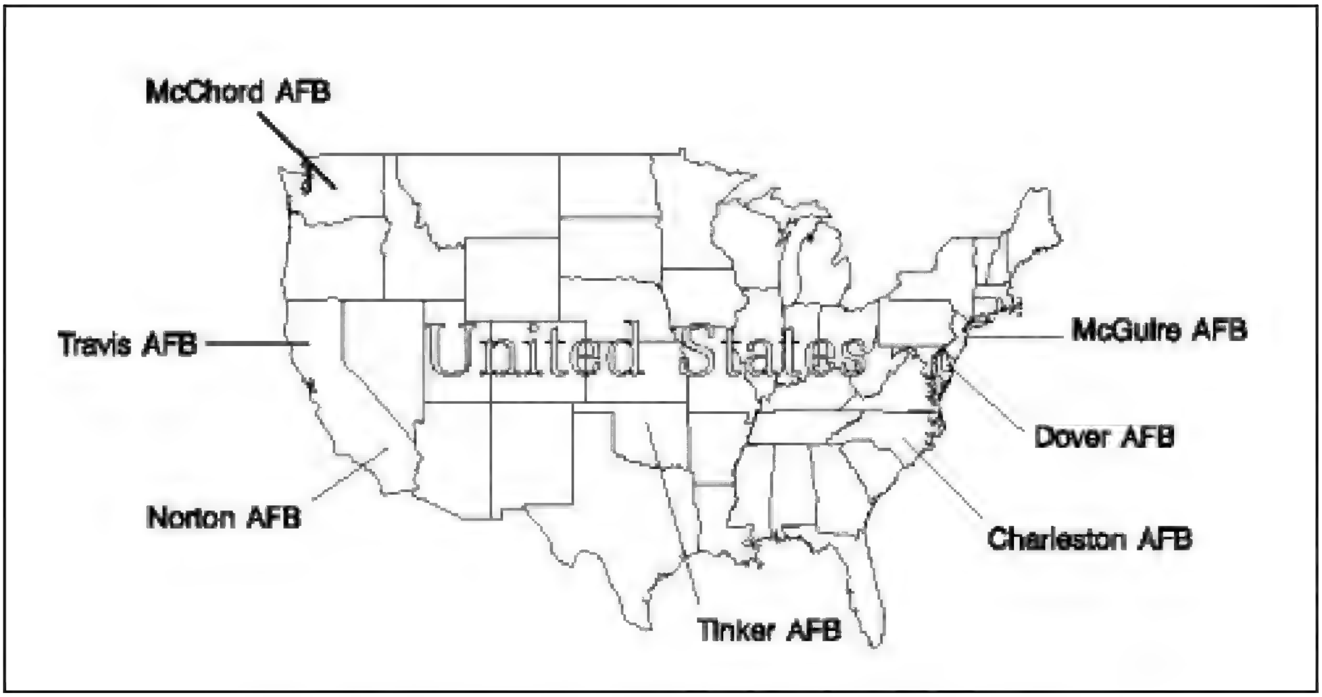


Figure 4. Major Desert Shield and Desert Storm Aerial Ports of Embarkation (21:13)

jammed the system, items not coded as priority ceased moving in many cases. As units in Saudia Arabia awaiting requisitioned items grew frustrated with the long delays experienced in receiving their orders, they exacerbated the situation by submitting new requisitions with a higher priority in an attempt to *game* the system. The result was even more congestion at the ports. The priority system rapidly degenerated until, in essence, no priority system existed. Cargo was simply moved in a first-in-first-out procedure that left real priority shipments on an even par with less crucial items (21:20). Many units failed to realize that airlift is not only a scarce asset but also tremendously expensive (1:18).

Backlogs of cargo at the APOE grew to staggering proportions. MAC's ability to move cargo out of these bases did not exceed 1,300 tons per day in either Desert Shield or Desert Storm. Backlogs were at their worst in January 1991 when the APOEs found themselves saturated with more than five times the amount of cargo MAC could accommodate (21:18). As sustainment cargo backlogs began to swell significantly in January 1991, MAC's cargo airlift capability was insufficient to meet the movement requirements for sustainment cargo being levied on it by the US Central Command. One factor in this shortfall worth noting is that, even in a time of crisis such as the Gulf War, MAC still had to devote some organic airlift missions to support other critical operations. In addition, the Department of Defense was hesitant to activate additional CRAF aircraft due to the potential adverse economic impact of such an action on US carriers (21:21).

Trucks and trailers are loaded onto transport aircraft. (Official US Air Force photo

Planning for the region called for the utilization of at least 34 offload locations in a Desert Shield/Desert Storm type of scenario. However, due to the physical and political restrictions that existed in the theater at the time, MAC was limited to no more than ten locations throughout the entire Gulf deployment (21:19). While US airlift planners were pleased to recognize Saudi Arabia has several sites with large runways and good surfaces, the majority of these airfields lacked the necessary infrastructure, such as refueling capabilities and the facilities required to support maintenance and aerial port personnel (21:20).

Airlift Shortfalls

The 1980 Congressionally Mandated Mobility Study (CMMS) conservatively estimated that the United States requires a 66- million-ton/miles per day airlift capacity to meet its global strategic airlift requirements. Even with its complete strategic fleet of 283 transport aircraft and with full

mobilization of the entire Civil Reserve Air Fleet of 506 commercial aircraft, the United States faces a capacity shortfall of roughly 18 million ton/miles per day (20:20).

The rapidly changing nature of Central Command's requirements, in part as a result of the lack of an operational plan for conflict in the region, caused MAC to operate in a reactive mode to users' widely ranging airlift priorities. Instead of being able to anticipate its taskings, MAC found any efforts to schedule its airflow more than a few days in advance were largely a waste. These abrupt changes in airlift priorities and requirements also played havoc with the users. On more than one occasion, MAC was tasked to have C-141s at an aerial port to pick up a unit only to discover upon the plane's arrival that some or all of the scheduled unit's cargo was outsized and would require a C-5 rather than a C-141 to move. On occasion, airlift arrived at a base, but the unit for which the airlift was designated had not received orders to deploy. Under such circumstances, aircraft either moved what cargo was available or were diverted to other bases that had cargo ready to move (21:22-24).

To alleviate the congestion at the aerial ports and the abuse of the priority system, the Military Airlift Command initiated a number of practices. Cargo teams were established at the two major APOE—Dover AFB, Delaware, and Tinker AFB, Oklahoma—to prioritize cargo and divert nonpriority items to sealift as appropriate. Each Service was given and limited to a fixed airlift allocation for its sustainment cargo requirements. Requests for airlift support were made to members of the North Atlantic Treaty Organization (NATO). As stated previously, the daily express cargo service, Desert Express, moved the highest priority cargo from the United States to the theater of operations in minimum time (21:24).

Initial allocations totaled 1,250 short tons per day. Later, this amount was raised to 1,600 short tons as the number of initial unit moves diminished and more airlift became available for sustainment operations (21:25).

This system, while generally effective, was not without its problems. The Services' actual requirements for airlift still exceeded available capacity. The Army's allocation, for example, was usually fully allocated within the first 3 hours of the day. Once the allocation limit was reached, the Services' Air Clearance Authority could designate no additional cargo for air movement on that day. Units and shippers, frustrated by their inability to have their cargo scheduled for airlift, bypassed the established control procedures and forwarded their cargo directly to the aerial ports. Once cargo was at the ports, handling personnel and MAC had no way of actually determining if cargo being prepared for airlift exceeded a given Service's allocation for a specific day. Thus, while the system helped somewhat, it was relatively easy for units and shippers to bypass the controls if desired (21:26).

User	Initial Allocation	Revised Allocation
Army	425	655
Air Force	190	240
Navy	105	175
Marine Corps	40	110
Defense Logistics Agency	40	5
European Command	150	215
Mail	300	200
Total	**1,250**	**1,600**

Table 1. Daily Cargo Allocations in Short Tons (21:25)

Civil Reserve Air Fleet

Operation Desert Shield saw the first ever implementation of the CRAF. Commercial aircraft in Stages I and II transported about 60 percent of the troops and 27 percent of the cargo airlifted to the Middle East (21:16). Stage I of CRAF was activated on 17 August 1990. The primary airlift requirement at the time was to support the movement of troops. The activation made 21 cargo and 17 passenger aircraft available to MAC (21:22). This provided strategic lift capability that would not otherwise have been available and without which the United States would have been unable to complete its force buildup in time to meet the UN imposed deadline for Iraq to withdraw from Kuwait.

Stage III CRAF activation was briefly considered for a time in January 1991. However, it was believed full activation of all of the reserve air fleet would severely disrupt the commercial airline industry. As a result, Stage III of CRAF was never implemented (21:22). The chief concern of airline managers was the loss of market share because of the diversion of aircraft to the military, particularly among cargo carriers as the holiday season approached (24:31).

While, for the most part, implementation of CRAF was a success, several concerns about the fleet's use and role in future US crises exist. For example, a shortage of ground support equipment delayed delivery and unnecessarily lengthened aircraft utilization times at many locations (24:31). In addition, many carriers were forced to operate for a time with no insurance for either their aircraft or their crews. Aircraft called up for use sometimes sat idle for days before they were utilized, but the carriers are only reimbursed for the time the aircraft is in flight, not the time it sits idle. Problems of this nature and others are leading to calls for an overhaul of the CRAF concept. No one is overly critical of the success of the system, but adjustments aimed at fairness and better flexibility are being implemented.

In the first phase, CRAF-activated civil transports operated 1,237 flights through 26 November 1990 at a total cost of $267.4 million. These aircraft moved 126,451 passengers, approximately 60 percent of the total deployment and 25,226 tons of cargo, about 20 percent of the total. Another 36 missions were flown as passenger and cargo mixed flights (24:32). The original callup activated 21 cargo transports. Through 26 November, 717 cargo missions and 432 passenger missions had been flown. Passenger missions averaged 292 passengers per flight, reflecting the heavy use of wide-body transports. Aircraft use ranged from as few as 10 per day to a high of 50 in Stage I of the activation (24:32).

US troops board a CRAF aircraft for deployment to the Gulf. Operation Desert Shield/Desert Storm marked the first ever activation of the Civil Reserve Air Fleet. CRAF aircraft played a major role in the deployment of US forces to the Gulf. (Official US Air Force photo)

Approximately 1.67 billion-ton miles, passengers and cargo, were flown as of 27 November, far exceeding the 697.5 million-ton miles accumulated during the Berlin Airlift. Stage II of the CRAF callup involved 17 percent US fleet passenger capacity and 30 percent of its long-range cargo capacity (24:32).

A Change of Plans

MAC war plans at the time assumed that an in-theater crew recovery base would be available soon after the onset of operations. In fact, no such base was ever established, and this significantly impacted strategic airlift operations throughout Operations Desert Shield and Desert Storm. Such a base was deemed to be required due to the extreme distance of the theater from US and European recovery bases. Space and facility limitations at the debarkation aerial ports did not allow transiting strategic airlifters or their crews to remain overnight. Instead, crews were forced to complete an extended Europe-theater-Europe flight in a single extended duty day of more than 16 hours. To accomplish this, more crewmembers and modified flight rules were required. In particular, the lack of an in-theater recovery base forced the Military Airlift Command to rely heavily on volunteer aircrews in the initial phases of Desert Shield and to require an official Reserve callup much sooner than expected.

An in-theater recovery base was a mainstay of MAC planning. Such a base would require adequate facilities for crews, including sleeping quarters and meal service, and a substantial aircraft refueling capability of at least 1.5 million gallons per day. US Central Command decided not to provide a recovery base due to physical space limitations at facilities in the theater and the desire to use the available bases for fighter, bomber, and tanker forces (21:29).

In order to meet the overwhelming logistics requirements, the Military Airlift Command was forced to make changes to standard operations. MAC not only had to augment aircrews to a greater extent than planned for but also had to modify or relax certain flight rules. Flying hour limits were increased from 120 to 150 flying hours per 30 days. Crew duty hour limits of 16 hours for a basic crew and 24 hours for an augmented crew were raised to 20 and 29 hours respectively (21:33). MAC was also forced to request similar waivers on behalf of the civilian aircrews and airlines supporting Desert Shield and Desert Storm under the auspices of the CRAF program and charter air operations.

During Desert Shield, Air Force Reserve volunteers augmented regular MAC crews from the onset of the operation, more than 3 weeks before the President formally initiated the callup of reserve forces. Without these volunteers, MAC simply

would have not had enough aircrews to perform the required missions in the first weeks of Desert Shield. During the first few weeks, Reservist volunteers flew 42 percent of all strategic airlift missions. Once formally activated, about 50 percent of MAC's aircrews and aerial port personnel were reservists (21:36-38).

In-Country Distribution

Distributing supplies once they arrived in theater was a major logistics challenge. The road network in the region was never designed to handle the extensive volume of traffic generated by the force buildup, and rail lines were virtually nonexistent. One Army source called the in-country distribution effort by far the most challenging:

> The main reason distribution is such a problem in the Gulf is that the dense infrastructure of roads, railways, airfields, ports, buildings, and other structures do not, by and large, exist among the Gulf States. In large part, because their populations are fairly small in relation to the land area they cover, these countries have not developed many of these things (1:22).

Fuel was one of the major resources requiring in-theater distribution. The US Army estimates that one division of 350 M1 tanks consumed more than 600,000 gallons of fuel a day, nearly twice the consumption of General George S. Patton's entire Third Army in its 1944 drive across France. Transporting supplies to an armored division by truck required ninety-eight 5,000-gallon tankers and two hundred and ten 5-ton cargo trucks daily (9:9). Thus, movement of materiel within the theater was in itself a major logistics effort. Ironically, advances in technology also increased the strain on logistics efforts because advanced night vision equipment enabled combat to continue around the clock. This meant distribution channels had to operate at full capacity 24 hours a day (1:23).

Refueling attack helicopters at a forward location. (Official US Air Force photo)

Theater Logistics

Because of the pressing urgency of the initial deployment to the Gulf and a strong possibility that Iraqi forces might move on Saudi Arabia before a substantial US defensive presence could be established, the decision was made early on to deploy combat units significantly in advance of their supporting units. This meant that at the operation's onset US forces found themselves without their standard established logistics structure. Eventually, the size of the US logistics force in the region grew to more than 40,000 with about 60 percent coming from the Reserves or the National Guard (11:1).

To facilitate a secure logistics base in the Gulf theater, support personnel built roads and laid pipeline. Supplies needed by combat troops were transported forward to strategic locations near the front lines in order to make them more accessible to the troops. US forces even went so far as to build a helicopter refueling strip inside the Iraqi border to provide for faster servicing and turn times for combat helicopters involved in close air support of allied forces (4:21).

A critical difference between supporting Desert Shield and supporting a combat force of the same size in a European theater was the road system. The challenge in Saudi Arabia was getting the critical tonnage of food, fuel, and bullets from the aerial ports of debarkation and seaport of debarkation forward to the combat maneuver units (9:9).

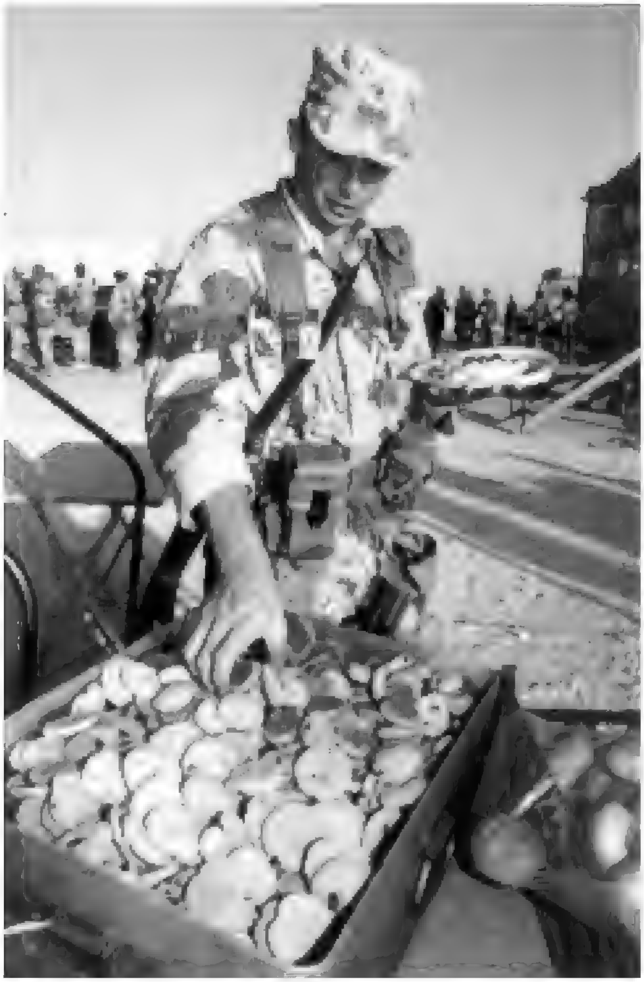
Food, Subsistence, and Rations

Military commanders have often subscribed to the notion that the quality of the food available to fighting forces in the field will impact their performance in combat. For this reason, providing adequate rations for military personnel in the field is of paramount concern to the managers of the supporting logistics system. Using mobile kitchen facilities, existing dining facilities, and host nation contracted support, the Department of Defense was able to meet this goal for the majority of deployed personnel. However, due to their locations, some Army and Marine Corps units had substantial difficulties obtaining a variety of foodstuffs and alternatives to meals-ready-to-eat (MRE) rations.

Food Services

Throughout the theater of operations, commanders were given significant latitude to provide the highest quality rations they could obtain given the constraints of the existing environment.

The variety and type of rations provided depended entirely on where a given unit was stationed and the type of preparation facilities available in the area. Air Force units, enjoying the relative benefits of operating from stable, fixed locations, generally enjoyed fresh food supplied by host nation contractors. Army and Marine units, by nature of their constantly changing positions and tactical environments, had to subsist mainly on MREs and occasionally on tray-pack T-rations. Fresh food was made available whenever the situation permitted, with deliveries of limited quantities of morale-



US personnel visiting the traditional military *chow line.* The variety and type of rations provided depended on where the unit was deployed and the food preparation facilities available. (Official US Air Force photo)

boosting favorites such as fresh fruit delivered by whatever means of transportation happened to be operating in the area.

Less than a month after President Bush committed troops to Saudi Arabia, the Defense Logistics Agency (DLA) had shipped 15.6 million MREs and 2.6 million tray-pack rations to the theater. They also sent 10 million loaves of bread, 6.3 million pounds of meat, 4.9 million pounds of fish, and 2.8 million pounds of fresh fruit and vegetables (3:12).

The Services did their best to provide fresh or frozen foodstuffs and other supplements such as fruit, juices, soft drinks, and the like from facilities located throughout the region. Each Service developed a daily feeding plan, outlining the types and quantities of meals supplied to its troops in the field. The Army feeding plan called for one MRE and two hot meals provided to each soldier daily. Illustrating the difficulties encountered in theater, the Army was never able to meet this plan due to the inability of producers in the United States to meet the actual demand for T-rations that materialized during the Gulf War. As a result, the Army relied on MREs and B-rations, which, in turn, prompted a shortage of the components for B-rations, in particular meats and vegetables. Here again, the cause was the inability of the domestic producers to meet the unanticipated demand requirements for these components by deployed US forces.

In response to these shortages, the Army developed and adopted meals, off-the-shelf, ready-to-eat (MORE)—a product generally well accepted by the troops and often a welcome change from the stock MRE the majority of forward employed ground troops had grown accustomed to.

Recognizing the importance of food to maintaining troop morale and the potential ill effects of limited diverse rations, the *Wolfburger* stand was developed. The brainchild of a warrant officer aide to Army Major General Pagonis, the Wolfburger wagon was nothing more than a military adaptation of the portable hamburger and hot dog stands commonlyused by the American public at local fairs. Towed to forward locations, often in close proximity to the actual front lines, these mobile kitchens provided a variety of short order foods centering on fare such as hamburgers, hot dogs, and French fries. A significant hit with the troops, Wolfburger stands proved an innovative and morale-boosting means of improving the quality and variety of meals received by Army personnel in the theater.

The Army recognized the limitations of its troop feeding plans. Specifically, the operation highlighted the inability of the industrial base to respond effectively to increased demand on short notice. Under circumstances of more direct hostile action by opposing forces, reliance on traditional prepackaged foods such as MREs is expected. However, the importance of good food to supporting the morale of troops exposed to extended periods of combat means that alternative rations should be a significant planning issue for future combat operations.

The Marine Corps feeding plan was similar to that of the Army in that it called for one MRE and two hot meals daily. Within 1 week of arrival in theater, the Marine Corps was serving its first hot meal. Within a month, a majority of Marine Corps personnel were receiving two hot meals a day.

Rations for Air Force personnel were far more abundant and varied than those available to their Marine Corps and Army counterparts. Relying initially on rations included in prepositioned storage sites, managers had these rations moved to operating locations in advance of the arrival of the forces. These rations, consisting primarily of MREs and B-rations, provided Air Force personnel with a sizable initial operating stock until other ration sources became available. Thus, Air Force units never faced any real possibility of a shortage of quality rations. The ready availability of prepositioned MREs, B-rations, and Harvest Falcon kitchen equipment sets provided the Air Force with a substantial advantage in food service capability in the early phases of employment operations.

When it came to the actual preparation of field rations by military food service personnel, the different Services experienced varying degrees of success with existing field kitchen equipment. The Army relied heavily on a mobile field-cooking trailer that proved extremely fragile and worked well only in the most ideal circumstances. The trailers offered only

limited protection from the environment, and sand was constantly finding its way, not only into the internal workings of the unit but also, to the dismay of the troops, into the food being prepared. Food heaters were also ineffective or failed to work at all.

The Air Force's experience with its mobile field kitchens was somewhat better. Relying heavily on Harvest Falcon field kitchens, the Air Force's main problems stemmed from a shortage of readily available spare parts. When equipment on the units failed in the field, replacement parts, readily available in the States, were difficult to obtain as they had to be procured through regular supply channels and then compete for transportation among the plethora of higher priority cargo moving to the theater. In this vein, the Marine Corps had a similar experience as field kitchen equipment failed at higher-than-anticipated rates due to the unaccustomed length of use and the degradation induced by the blowing sand and generally harsh climatic conditions in which the equipment was utilized.

The Air Force replenished B-rations from theater stocks on an as-requested basis. In addition, the relatively fixed locations at which the majority of Air Force personnel were billeted allowed Air Force food service management to rapidly transition the existing feeding capability to an almost cafeteria style operation using host nation contractors. Such contractors provided fresh food on a daily basis, a wide selection of beverages, and personnel for cleanup and maintenance of dining facilities. In some instances, host nation personnel also provided food preparation and service. While generally allowing for the highest levels of food service and variety of fare available during the conflict, reliance on contracted personnel also led to unexpected problems. At several bases, Air Force personnel were left with no way to prepare meals when contracted personnel left the installation after a warning of impending chemical attack. This situation was only alleviated when contractor personnel returned and were provided with appropriate protective equipment.

While there were shortages of certain types of rations in the initial phases of the deployment, one type of ration that was never in short supply was the MRE. In fact, due to the relatively short duration of Desert Storm, there was a surplus of MREs and B-rations. By April 1991, the Army's Materiel Management Center at Dhahran, the theater manager for food items, projected that a minimum of 16 million MREs were available in theater. The Air Force found itself with 50 to 70 40-foot shipping containers with an estimated 1 million meals valued at $4.5 million. The Marine Corps likewise reported it had more than 3.5 million MREs available in theater and another 2 million available aboard supply ships in the region.

Given the abundance of the MREs, the Army Support Command actively encouraged soldiers rotating back to the United States at the conclusion of hostilities to carry at least a 3-day supply. This not only helped to eliminate the immediate stocks of forward deployed rations but also minimized the need to feed large numbers of transiting Army personnel during sometimes lengthy delays at intermediate points on the route back to the United States. The remainder of food in country was designated for transfer to the World Food Bank for redistribution to needy countries. The majority of B-rations were used to feed Iraqi refugees during subsequent humanitarian assistance operations. The US Marines, ever resourceful and recognizing the Army's responsibility for overall management of food within the theater, simply transferred its stocks to the Army for disposition.

Bottled drinking water is moved from central storage to troops in the field. Stocks of potable water have always been a critical factor for military operations, and the Gulf War was no exception. (Official US Air Force photo)

Water

Distributing water beyond central points to individual units was a transportation-intensive operation.

Water to support laundering of hospital linens generated a considerable additional demand. For example, a 400-bed evacuation hospital had a 28,000-gallon per day water requirement (9:8).

The US Army served as the chief water bearer for the four Services. That responsibility ultimately required the Army to provide 20 gallons a day per soldier, sailor, airman, and marine as well as onsite civilian advisors and contractors. The per-

Medical personnel treat a *troop* overcome by heat and dehydration. (Official US Air Force photo)

During the Gulf War, the United States deployed two naval hospital ships, the *USS Comfort* and *USS Mercy* (seen above). (Official US Air Force photo)

person daily allotment included 6 gallons for drinking, plus water for cooking, washing, hygiene, and vehicle radiators (3:12).

In addition to water obtained from approved host-nation supply sources, reverse-osmosis water purification units were used to produce potable water from fresh, salt, brackish, and chemically contaminated water supplies. Production capacities for these units ranged from 9,600 gallons per day for smaller units to 110,000 gallons per day for the largest. Local distribution was provided through an intricate network of water *buffaloes*, drums, bladders, and miles of hose (3:12). Long-haul trucking of potable water was used where no local source of supply existed or could be developed. In many cases, portable water purification units were used to minimize transportation requirements.

Medical Support

One of the most prevalent complaints encountered by deployed medical service personnel were various intestinal disorders associated with acclimatization to the food and environmental conditions in the theater.

Occasional incidents of heat exhaustion and dehydration were also encountered as well as several run-ins with venomous insects and snakes. (6:16).

A central mail facility set up to handle the large volume of mail generated during the Gulf War. While mail proved to be a definite morale booster during the Gulf War, as it has in all previous wars or conflicts, it did require a substantial amount of airlift. (Official US Air Force photo)

Mail

The public outpouring of support for US forces was overwhelming. Schoolchildren, veteran's groups, and ordinary citizens wrote letters and sent care packages, tapes, and magazines that were shipped by military aircraft through the already congested APOE. Postal authorities reported more than 30 million pounds of mail were shipped from the beginning of Desert Shield until Christmas. On 30 November alone, 617,000 pounds of mail were airlifted. Assigning priorities became a much more difficult task.

The defense depots routinely used express mail to ship thousands of small parcels to the theater. These parcels competed with standard mail and care packages for limited airlift to the theater. The Desert Express route resolved this conflict, but the logistics of moving hundreds of thousands of pounds of mail remained a major challenge. In order to alleviate the burden of distributing mail to the theater, on 19 January 1991, the Department of Defense requested that well-wishing troop supporters at home stop sending packages to deployed forces and limit mail to letters (1:21). By 5 February 1991, the postal service was handling 273,300 pounds of mail per day to Saudi Arabia. At an average of five pieces per pound, that was more than 1.3 million items per day. That volume was down from the January high of an average 419,000 pounds per day. The sheer volume of mail flowing to the Gulf region was not the only factor making mail distribution challenging. The situation was further complicated by the constant movement of troops and their units, which significantly increased the difficulty of forwarding the mail to the hundreds of Army, Air Force, and Fleet post offices scattered throughout the theater (25:4).

In addition to mail handled through formal postal channels, airline flight attendants and pilots began collecting magazines and books to bring over with each flight. Volunteer groups back in the United States gathered books, magazines, board games, and playing cards to be sent over with unit cargo whenever space would allow (6:17).

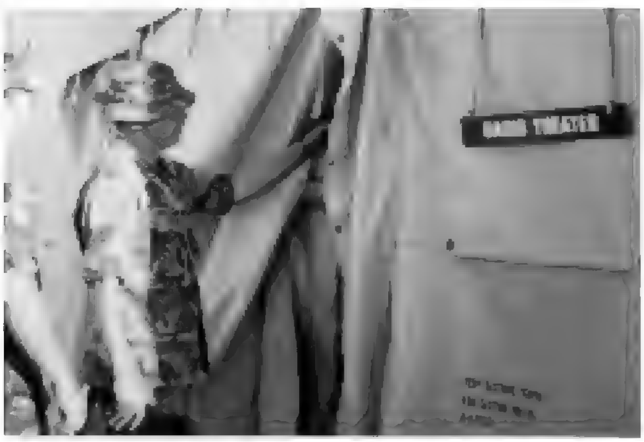
To maintain the morale of deployed troops, especially during the Christmas season, mail was first on the US Central Command's priority list. In one mid-December 1990 report, the cargo diversion team at Tinker AFB reported that more than 50 percent of all aircraft departing were loaded with mail (21:24).

Petroleum, Oil, and Lubricants

The Gulf War was unique in military history as the first conflict in which any significant percentage of US tanks, ground vehicles, aircraft, and ships were powered by the same type of military jet fuel. While not universal, JP-8, a kerosene-based

fuel, was used in a diversity of vehicles. Included were the Army's M1A1 Abrams main battle tank, self-propelled howitzers, and Bradley fighting vehicles. The fuel was also used to power Army helicopters and at least one Navy ship with a gas-turbine engine plant. The majority of Air Force aircraft used JP-8 as well (26:6). The ability of systems to use a common fuel simplified the logistics of fuel distribution and more importantly provided commanders flexibility to obtain fuel from the most immediately available source. Since it was left to the individual commander's discretion as to which fuel to use, the decision largely rested on fuel most readily available in the immediate area. The use of a single fuel, while not essential to the successful outcome of the Persian Gulf War, provided an opportunity to test a concept that could conceivably be vital to future US operations in more fuel-critical theaters.

Harvest Falcon



Tent theaters were among the morale, welfare, and recreation facilities established to support US personnel during the Gulf War. (Official US Air Force photo)

Initial Harvest Falcon deployments of the Air Force included items to support housekeeping and mission-support operations: lighting sets, washers, dryers, shower and shaving units, portable latrines, and electrical cable. This equipment provided for immediate needs and aircraft support. Harvest Falcon assets were designed to support up to 750 aircraft and 55,000 personnel (27:23).

Morale, Welfare, and Recreation

Once the immediate support needs of US forces were attended to, the Services took active steps to improve the quality of life of deployed personnel. The Air Force Commissary Service deployed more than 100 personnel to distribute food and run tactical field exchanges.

Mini-exchanges offered a limited supply of toiletries, writing supplies, and comfort items. They were stocked and operated by the Army and Air Force Exchange Service while manned by the commissary service as a part of its wartime mission (27:22).

Shortages

It is important to note that, as supplies moved to the Persian Gulf, depots also received new supplies from vendors and manufacturers at an almost equal rate. Shortages of items such as MREs sometimes required depots to adopt innovative solutions through the use of similar alternative items. For example, Hormel's Top Shelf prepackaged meals were issued until MRE stocks could be replenished (1:24).

Some items could not be replenished as quickly as they were shipped. Modern sophisticated weapons such as laser-guided antitank missiles (like the Hellfire for US AH-64 Apache attack helicopters) and sophisticated antiaircraft missiles are not produced in large quantities. Increasing production rates for rapid delivery is difficult because production lines are limited for major components like complex electronics. Other factors that made it difficult for vendors to rapidly increase production rates include limited numbers of skilled workers who assembled components, availability of special materials, and limited resources (1:25).

The combined problems of limited initial stocks and low production rates meant it was possible for US and allied forces to run out of certain items. If the Gulf War had lasted longer, it is unlikely that production could have met demand and permitted restoration of stocks (1:25).

On 9 January 1991, President Bush issued an executive order compelling civilian manufacturers to give first priority to the military. At the start of Operation Desert Shield, some government planning experts believed the United States had less than a 10-day supply of certain critical munitions. The reasons given for such shortages included the Services' preference for high-tech weaponry over the last 20 years, a sharp reduction in orders during the year prior to Operation Desert Shield due to the belief the Cold War was over, and the fact that the commanders of forces in the Gulf were requesting more ammunition than Pentagon planners had expected.

Items in short supply included some varieties of tank and artillery shells, machinegun rounds, rockets, mortars, and other *dumb* munitions with high expenditure rates. In an interview before Operation Desert Storm, Army Major General Paul Greenberg—commander of the Armament, Munitions, and Chemical Command, the agency that buys munitions for all of the military Services—reported that shortages existed or were anticipated in numerous ammunition categories. The general went on to state that ammunition requisitions from Central Command forces were averaging about 125 percent of the planned consumption rates for a typical ground war (28:1).

In the short run, Gulf force commanders were able to get around these shortages by turning to NATO allies for access to their stockpiles of munitions designed to be interchangeable with US weaponry. While NATO allies were generous in their willingness to provide such support, this was not a panacea. There were technical problems stemming from the environmental differences between Saudi Arabia and Western Europe. In many

Munitions storage and buildup (assembly) facilities were established at a number of locations during the Gulf War. (Official US Air Force photo)

cases, this was the first time US equipment was employed with allied ammunition (28:1).

By the end of November 1990, the Army had dipped into its European stockpiles for 1,000 Hellfire antiarmor missiles, 3,000 Tow II antiarmor missiles, 4,000 105-millimeter artillery shells, and 900,000 rounds of 25-millimeter machinegun ammunition. During the first weeks of Desert Shield, the Air Force requested and received from Congress an extra $40 million to order 600 additional GBU-27 laser-guided bombs for immediate production (7:2).

The reason for such shortages will no doubt be the subject of much controversy and debate for years to come. However, one aspect of the problem widely agreed upon is the Services' preference for high-tech weaponry over so-called *dumb* systems has promoted inventory shortages of the less sophisticated but still vital weaponry. The ultimately successful employment of many high-technology weapons systems in the Gulf War is seen by many as vindicating the Services' desire for more expensive, higher technology systems. The fact that the United States has never succeeded in building up a planned 60-day wartime operating stock of required ammunition should be a prime logistics concern inherent in the planning for any future military campaign. Clearly, a mix of both *smart* and *dumb* systems is required due to the wide range of target types and mission profiles encountered on the modern battlefield. The critical question for logisticians will be whether the *correct* balance of weapons types is available and whether the stockpiles of each are sufficient to support protracted combat operations as opposed to the limited combat phase encountered in Operation Desert Storm.

Uniforms

An item that proved to be of significant concern to deploying troops and in short supply throughout DoD supply channels was the desert camouflage battle dress uniform (BDU). Many servicemen heading to the Middle East found that the desert BDU was unavailable through military supply channels and not stocked in military clothing sales stores. Therefore, many servicemen were forced to do their own shopping at military surplus stores for such items as the basic desert BDU ensemble, hats with wide brims appropriate for the desert environment, and lightweight desert boots designed for the sandy environment of the Saudi Arabian peninsula. Servicemembers really had little choice. They could either choose to buy the uniform themselves or go without. Given the high degree of uncertainty in the initial phases of Desert Shield as to specific

threats an individual was likely to encounter and which personnel were likely to become actively involved in a combat environment, a large number of personnel chose to use their own funds to purchase this *issue item* otherwise unavailable through DoD supply channels (29:10).

Both the Army and the Marine Corps had difficulty with availability and sizing of uniforms, boots, and particularly, chemical defense ensembles. The Air Force experienced many of the same types of problems. In addition, the Air Force experienced desert camouflage uniforms being available to only approximately 20 percent of its personnel in theater.

Scavenging War Supplies

To frontline officers, the most adept scavengers became vital to obtaining needed supplies that bogged down in a saturated logistics system. Scrounging and scavenging, as in so many wars before, evolved to a fine art during Operation Desert Shield. Seen as a way around the long delays associated with massive requisition backlogs, units of all the Services found themselves in the business of *appropriating* or *liberating* needed materials to meet unit needs. Units were as apt to *borrow* what they needed from other units of their own Service as they were to commandeer materials from elements of the other Services. In addition to the outright covert raids carried out to obtain needed items, units became involved in an unofficial system of barter and exchange to meet their mission requirements. Thus, unit supply personnel might hold or obtain items needed by other units in order to gain an advantage in future negotiations. While the costs and benefits of this informal logistics system may be immeasurable, the existence of such a system has been an inseparable part of military campaigns throughout history (30:1).

Army troops wearing green battle dress uniforms board an aircraft for deployment to Southwest Asia. Supplies of the desert camouflage uniforms proved to be a problem during much of the Gulf War. (Official US Air Force photo)

Observations

The fact that the United States was able to successfully deploy the necessary forces and equipment to the Gulf should not be taken as across-the-board proof that it could accomplish the same feat again for future conflicts. Operations Desert Shield and Desert Storm were unique in a number of respects. First, US forces had an unprecedented amount of time, 161 days, to set up the theater in preparation for combat operations. Setting up the requisite logistics infrastructure and positioning and posturing US forces in the face of active enemy resistance would have been considerably more difficult. Also, the existence of many modern bases, ports, and airfields throughout Saudi Arabia lessened the degree of preparation needed. In fact, the Saudi Arabian ports used in Desert Shield and Desert Storm are some of the best in the world. The Saudis also provided fuel, water, and ground transportation, as well as some housing and provisioning support (31:8). Desert Storm demonstrated that the United States is dangerously short of cargo ships and aircraft needed to get troops and weaponry from the United States to distant trouble spots in a hurry. As Admiral Butcher stated, “It’s dangerous to use Desert Shield and Desert Storm as a good example of what we can do in sealift because 47 percent of it came from foreign ships, which might not be available in the next emergency.” Another advantage that the United States could not count on in a future conflict, he said, is the use of Saudi Arabia with, “the best seaports, the best airports.” The foreign support, he stated, brought out not only the help of their cargo ships and planes but also permission to fly through their airspace (32:7).

Says military analyst David Isby, paraphrasing a German general who served in Rommel’s African desert campaign, “They always used to say the desert was the tactician’s paradise—and the logistician’s hell” (31:8).

“Everybody has done a superb job in getting the troops and materiel to the other side of the world,” said Vice Admiral Paul D. Butcher, a veteran military planner and deputy commander of US Transportation Command at Scott AFB, Illinois. “But we ought to keep in perspective that we’ve had the luxury of time—161 days to land all that stuff with nobody firing a shot” (32:7).

Chapter Four

After the Storm

Operations Desert Shield and Desert Storm represented the largest movement of men and materiel since World War II. With the successful conclusion of operations, the focus of the logistics effort shifted from supporting combat and sustainment-related activities to redeploying personnel and recovering and redistributing materiel from the Southwest Asia theater of operations (1:34).

A Logistics Success

At the height of Desert Storm, more than 500,000 US military personnel were stationed in Saudi Arabia and Kuwait (2:2). More than 95 million meals were served, enough to feed the entire population of the State of Rhode Island for 1 month. US forces consumed almost 1.5 billion gallons of fuel, an amount greater than the annual yearly consumption of 17 US states. US Service personnel received more than 32,000 tons of mail, amounting to more than 8 million cubic feet—enough to cover 15 football fields to a depth of 6 feet. Supplies were hauled forward using 1,400 US Army trucks and 2,500 host nation vehicles. More than 3,600 convoys traveled almost 3,000 miles on main supply routes for a cumulative distance equivalent to driving around the world 1,800 times—64 million miles. More than 117,000 wheeled vehicles, 13,000 tanks and other tracked vehicles, and 1,749 helicopters were moved to the theater. Additionally, 350,000 tons of ammunition were forwarded to Southwest Asia (3:8).

Representative of the logistics success story that underlies Operations Desert Shield and Desert Storm, the figures also reflect the truly massive extent of the retrograde logistics effort required to remove the equipment from the theater and ultimately return it to combat ready status. The equipment, materiel, and supplies needed to support effective air and ground combat operations demonstrate a successful logistics effort of unparalleled proportion. Yet, once hostilities concluded, the logistics effort was still unfinished. Arrayed across the desert were hundreds of thousands of US military people, immense stockpiles and inventories of munitions, building materials, vehicles, rations, and spare parts.

Operation Desert Farewell

The focus of the logistics effort for the previous 17 months had been moving supplies and equipment to the theater of operations. However, when hostilities concluded on 24 February 1992, the entire logistics machine had to be thrown into reverse to facilitate a rapid withdrawal of US forces from the region. Less well known than Operations Desert Shield and Desert Storm that preceded it, Operation Desert Farewell represented a logistics effort to return materiel, supplies, and equipment to prewar stockage and readiness levels. It also entailed the sum of the efforts required to remove all traces of the US presence from Kuwait and Saudi Arabia, except as provided for in materiel prepositioning agreements.

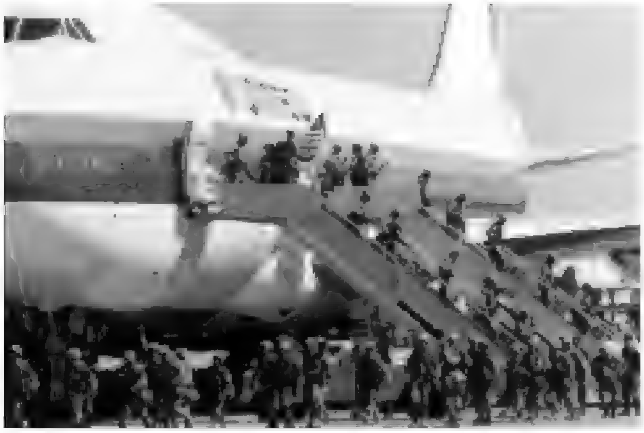
Redeployment

The earliest phases of Desert Farewell involved moving as many personnel and as much of their equipment as possible out of the theater in as little time as possible. The need to remove the large contingent of US forces from Saudi Arabian and Kuwaiti soil was fully in keeping with President Bush's pledge at the onset of hostilities to get US forces in and out of the region as quickly as events would allow. When President Bush announced on 6 March 1992 that hostilities were over, planes were already on their way toward Dhahran, Saudi Arabia, to transport US troops back home. By the morning of 8 March , the first contingent of 5,000 troops was several hours into the first leg of its flight home. This 5,000-people-a-day stream was to continue until almost the entire 500,000 plus were back in the United States. By 1 April, 165,000 US troops had been sent home. By 1 July, this number had reached 365,000 (4:155).

One of the most daunting portions of Operation Desert Farewel, was the reconstitution of supplies and equipment used in the Gulf War. Wartime operating stocks consisted not only of equipment actually used in the war but also thousands of tons of materiel still loaded in containers in Saudi Arabia, neighboring Gulf States, and at ports in Europe and the United States. Stocks actually issued to units for use—whether vehicles, munitions, equipment, shelters, supplies or rations—presented even more difficult disposition decisions due to the varying states of deterioration found in inventory actions.

Plans and Challenges

Items were widely dispersed throughout the theater, and the rigors of heavy use, combat, and a harsh desert environment left some equipment completely unsalvageable. The remainder had to be collected, packed, and transported to a central location then unpacked, inventoried, cleaned, and repaired (6:7). Whenever possible, assets were supposed to be returned to a 100 percent mission-ready status prior to movement from the Southwest Asian theater. However, this was next to impossible, as items ranging from combat damaged equipment



US troops return to the United States. The first priority following the conclusion of the Gulf War was to return the troops home as quickly as possible. (Official US Air Force photo)

to equipment ensembles were left less than mission ready due to shortages of supplies in the local area (6:7;1:36).

The challenge of Operation Desert Farewell was to not only redeploy the personnel, supplies, and equipment that the United States had spent 17 months moving to the Gulf area but also to return the majority of the assets to a mission-ready status. The challenge of returning units to before-the-war readiness levels was exacerbated by personnel drawdowns and budget shortfalls.

The first priority for the United States, both politically and militarily, following the conclusion of the combat phase of the Gulf War, was to bring the troops home as rapidly as possible. To live up to promises made both at home and to nations in the Gulf region, US military personnel were withdrawn as quickly as they could return to their assembly areas and obtain transportation. This haste in getting people out complicated the retrograde logistics scenario significantly, but it was an unavoidable consequence of the political realities of coalition warfare in the Gulf region.

With the exception of the Vietnam War, the US military did not have recent experience with major retrograde operations.

Helicopters prepared for return shipment to the United States. The protective wrapping seen here was necessary when the return was via sealift. (Official US Air Force photo)

Furthermore, the retrograde scenario encountered in Vietnam differed quite markedly from the situation facing military logistics planners following the conclusion of the Gulf War.

The Vietnam retrograde was conducted while a high-intensity conflict was still in progress and, although a great deal of military equipment was evacuated to the CONUS or to other locations away from the theater, a substantial portion of materiel available in theater was left for the use and support of the South Vietnamese government after the withdrawal of US forces (7:38). Equipment evacuated from the theater and returned to the United States was gradually overhauled over the course of several years and ultimately used to minimize the effects of equipment procurement shortfalls that occurred during the lean budget years and military drawdown following the US withdrawal from Southeast Asia (7:39).

Changing Logistics Focus

In the case of the Gulf War, despite victory and the sudden cessation of hostilities, the logistics effort continued unabated. The logistics focus shifted throughout the operations, from active support of tactical combat operations to sustaining the combat forces charged with clearing enemy forces from Kuwait and then to redeploying forces out of the theater (3:6). This was to constitute a significant effort in keeping with the promise by President Bush to the world community and, particularly, to the Arab states of the Persian Gulf area to get the job done as quickly as possible and then rapidly disengage US forces and withdraw from the region.

Redeployment Plan

During the time the United States was preparing for Operation Desert Storm, agreements were being made between the United States and Saudi Arabia. One of those agreements was that the US military would make a quick exit from Saudi Arabia after the war and remove the equipment and supplies brought in to support this operation. Colonel Randy Geyer, of the US Central Command logistics staff, had voiced his opinion that the preliminary plans for redeployment were weak. Based on his observations, he was tasked with developing a more comprehensive plan for redeployment. The new plan called for a two-stage approach. Stage I would be a personnel redeployment to move 365,000 troops in 90 days. Stage II would account for, segregate, and load for shipment all of the supplies left behind by the departing forces. It allowed for a year or more to accomplish this task (4:150).

From their onset, redeployment operations encompassed the return of both materiel and personnel. Preparations for the redeployment of equipment required all materiel be thoroughly cleaned and inspected to remove any potential contaminants. Staging and wash facilities were established at Dammam, Dhahran, Al Jubayl, and King Khalid Military City—facilities that became the major collection and staging points for equipment and materiel awaiting subsequent redeployment (3:6).

As logisticians struggled to get a handle on the immense quantity of materiel in the logistics system, they came to the

realization that, while it was next to impossible to determine the overall tonnage or volume of materiel that required retrograde, for the most part, it consisted of two broad categories—undelivered cargo and distributed materiel.

Undelivered Cargo

The majority of undelivered cargo was in 40-foot seavan containers and, for the most part, had never actually been released from the ports to the supply distribution system in theater. In addition, thousands of seavans had been *landed short* in Egypt, Spain, the United Arab Emirates, and several other European countries due to the massive backlogs at the Saudi Arabian ports. Thousands more were either awaiting unloading or were stacked at the ports of Dammam and Al Jubayl when hostilities ceased.

While the problem of distributed cargo was one that would occupy the majority of the logistics staff's time and effort, the problem of undelivered cargo was more readily solved. At the direction of the theater logistics commander—Lieutenant General William G. Pagonis, US Army—all short-landed containers coming directly from vendors were returned to their point of origin or to a DLA-designated storage facility. Containers destined for units already redeployed were forwarded to the unit's home location.

Cargo awaiting disposition in a cargo marshaling area. (Official US Air Force photo)

This action effectively removed a sizable concern from the theater planners, which in turn allowed them to concentrate on opening and inventorying containers already landed in Saudi Arabia and collecting and categorizing the substantial volume of distributed materiel flowing into theater collection points at a steady rate (1:35-36).

Distributed Materiel

Moving the materiel to the collection points was a major aspect of retrograde logistics operations. One solution to the problem was found in the US Army's 711th Transportation Group (Provisional), which was created to address the need for line-haul transportation in support of retrograde materiel movements following the conclusion of hostilities. Consisting of three subordinate battalions, the 711th controlled a fleet of more than 2,500 assorted tractors, flatbed trailers, lowboy trailers, heavy equipment transporters (HETs), and additional miscellaneous light and heavy transportation vehicles. The majority of all vehicles used to support retrograde line-haul operations were supplied through contracts with host-nation companies and their personnel. As retrograde operations moved into full swing, the surface theater transportation plan called for movement of 1,056 flatbeds and 520 lowboys or equivalent HETs on a daily basis. This volume of traffic was heretofore unimaginable to Army planners. The mission called for the equivalent of 22 medium and 12 heavy truck companies, a number almost twice as large as the size of the Army's entire 37th Transportation Command (5:18-19).

The distances and conditions under which trucks and equipment were required to operate were extreme. Vehicles making a typical round trip covered more than 600 miles of hazardous roads in extremely high temperatures. Dust, blowing sand, sandstorms, and smoke were daily inconveniences. The variety of equipment allowed little interchangeability among vehicles, and a system of trailer transfer points was not possible. Drivers were required to drive entire routes over the course of several days. The majority of drivers provided by Saudi contractors were third-country nationals speaking little or no English (5:18-19). Though capable drivers, cultural differences sometimes complicated the lives of logistics support personnel. Army ordnance personnel were particularly concerned with a typical driver practice of cooking meals on a small propane stove in the area immediately adjacent to the driver's vehicle. Ordinarily not a significant concern, the practice gained considerable attention when the trucks were loaded with tons of high-explosive ordnance (5:20).

Despite the existence of a highly detailed transportation plan, limitations in the logistics system were quickly realized. Trucks had to wait daily in long queues at heavily congested loading and unloading sites. Most of all, the availability of materiel-handling equipment, container- handling equipment, and qualified personnel to operate the equipment significantly affected operations. In addition, convoys were extremely large, typically more than 100 vehicles spread over 10 miles of difficult roadway. Without the benefit of communications, effective convoy control by the single Army NCO and assistant was less than ideal during the majority of movements.

Despite such limitations, the 711th Transportation Group achieved the objectives for which it was constituted. From 16 August to 15 November 1991, the 711th traveled more than 13 million miles. Trucks under the unit's control moved more than 260,000 short tons of supplies, 12,000 tracked vehicles, and 6,400 containers (5:21).

Morale, Welfare, and Recreation

Supporting commanders at the staging areas were particularly attentive to the morale and comfort needs of redeploying personnel, many of whom had been living in extremely austere conditions since their initial deployment to the region. Morale,

welfare, and recreation items were made available to redeploying personnel in addition to more basic commodities to provide for their everyday needs while awaiting outbound transportation. Popular wherever they were located, *Wolfburger Stands* were just as popular when made available to troops in the redeployment areas (3:6).

Restoration of Kuwait

As combat operations ended, the task of attending to the severe damage inflicted on both the people and facilities of Kuwait began. Under the auspices of the US Army's 22[d] Support Command, Camp Freedom was established in Kuwait to serve as the focal point for theater restoration operations. Humanitarian efforts were expanded to encompass refugee camps operated by US forces in Southern Iraq, to include primarily Kurdish-filled camps in northern Iraq and Turkey. In addition, the United States had to attend to the needs of more than 60,000 enemy prisoners of war taken during combat and immediately following the cessation of hostilities. Held in four camps, prisoners were to be provided shelter, medical attention, rations, and water until they could be processed by the International Red Cross for placement under Saudi Arabian control (3:6).

Although the majority of combat forces were redeployed out of theater from March to May 1992, most of their materiel was left behind in the desert or at the designated staging areas. The US Army alone left behind more than100,000 wheeled vehicles, 10,000 tracked vehicles, and 250,000 tons of ammunition (3:6). The extraordinary task facing logistics personnel was closing out the theater by efficiently, effectively, economically, and safely moving the materiel to staging areas and, subsequently, to final destinations. In the words of one Army specialist, this phase primarily centered on "bringing the iron out of the desert." For the US military, this was new logistics ground because never before in this century had US forces actually closed out a theater (3:6).

Fresh Forces

Given the adversity faced by logistics personnel in the 17 months of Operations Desert Shield and Desert Storm and the generally austere logistics infrastructure that existed within Southwest Asia both before and after the Gulf War, one of the first objectives undertaken by the US Army's 22[d] Support Command was to deploy about 6,000 new personnel into the theater to support retrograde operational requirements. In a similar vein, the other military Services augmented or replaced their existing logistics personnel with fresh, mostly volunteer, personnel from the United States. These newly arrived personnel not only provided badly needed logistics support as the number of personnel available for logistics duties rapidly decreased but also were a welcome replacement for many individuals who had been in theater for 12 to 17 months (3:6).

Long-Term Vision

Operation Desert Storm required the use of supply stocks from many different locations around the world. A part of the long-term vision guiding the logistics effort was the desire to return equipment from the theater to those facilities that were depleted over the course of the war. Military bases in Europe, Central America, South America, and Asia had sent supplies to help build up the stockage levels required to prosecute the wartime mission. These bases needed to have supplies replaced, and redeployment efforts attempted to accomplish this whenever feasible. Another part of the vision was to help Kuwait by sending some of the supplies to assist in sustaining the general populace and repairing the decimated national infrastructure. Additional materiel was repacked onto maritime prepositioning ships that then returned to their ready positions in the Indian Ocean (4:156).

Another part of the vision was to effectively dispose of dated materiel such as ready-to-eat meals and similar items. Food, fuel, water, and medical supplies were provided to the Kuwaitis following the war. This materiel would have to be packed and removed anyway but would have been destroyed if it were returned to the United States. Operation Provide Comfort, the UN relief effort to assist and protect Iraqi Kurds fleeing a hostile Iraqi regime, also allowed for the practical disposal of shelf-life-limited items that would have been otherwise destroyed. Sending items—such as tents, cots, blankets, water, excess MREs, and tray packs—to the Kurdish refugees fleeing Iraq, as well as helping other needy populations around the world with surplus food and clothing, was an effective and useful method of disposition (4:154).

To support a portion of the Air Force retrograde logistics effort, the Air Force Materiel Command formed the 4401[st] Asset Reconstitution Group (Provisional) for the express purpose of attending to the Air Force's share of the military equipment, supplies, and munitions left over from the war. For the Air Force, the key collection facility was Al Kharj, Saudi Arabia. Literally hundreds of jeeps, pickup trucks, Humvees, trailers, graders, fire trucks, and cars still formed regimented rows in the blistering desert sun almost 2 years after the fighting officially ended. In addition to vehicles, Air Force personnel had to contend with portable buildings, hangars, and tents. Virtually anything a unit could not immediately take with it when it redeployed eventually found its way to Al Kharj (6:6).

Other Considerations

Regulations imposed by the US Department of Agriculture were an additional constraint on the retrograde logistics effort. These regulations, contained in the Code of Federal Regulations, governed the importation of goods into the United States from any foreign location and set stringent guidelines that significantly affected the ability to return the massive amounts of equipment and supplies that were sent to the Middle East. These regulations were intended to prevent the accidental importation of crop-infesting insects that might be living in soil or sand residue found in or on the vehicles or other equipment. The regulations required that items returned to the United States first be steam cleaned and sanitized. Cleaning the equipment for transportation back to the United States required a huge logistics undertaking (8)

Washrack Units

To meet the requirements imposed by the Department of Agriculture, all loose soil and sand had to be removed from the vehicles prior to returning to the United States. As a result, four washrack units were set up to clean and sanitize the vehicles. More than 2,000 vehicles (air and ground), some of which had to be taken apart, were washed each day.

In some cases, engines were removed and tracks taken off M1 tanks in order to ensure they would be acceptable for return to the United States. Water for the washracks was brought to the sites by truck or pipeline, asphalt was laid to support the vehicles being cleaned, and sterile staging areas were built to store equipment until it could be shrink wrapped and held for transportation.

Ammunition was also required to undergo the same treatment. Some 350,000 short tons were sent through the washracks prior to shipping. Their washrack operation constituted the largest single operation in Desert Farewell (4:157).

Vehicle cleaning at one of the port wash facilities. (Official US Air Force photo)

Trucks being prepared for return shipment. Prior to return to the United States or other destinations, equipment had to be cleaned. (Official US Air Force photo)

Theater Closeout

The closeout of the theater by the US Army can essentially be divided into two distinct phases. Phase I, from June to mid-August 1991, consisted of the buildup of 61 provisional units using primarily replacement personnel. In concert with 6 active units from the Army Forces Command and 4 terminal transfer units, these units replaced 71 in-theater units that had ongoing missions. The replacement units were put in place and trained to do the jobs of their predecessors. The organizational structure of theater logistics support forces was also reconfigured to more readily support the retrograde logistics mission (3:6).

As an additional part of the first phase, massive equipment and munition stockpiles left in the desert were sorted and organized for retrograde disposition. In staging areas, transportation assets were marshaled to move stockpiled materiel to the port cities of Dammam and Al Jubayl. In all, nearly 50,000 truckloads were required to transport the massive quantity of retrograde materiel to the ports. More than 400 shiploads subsequently were required to move materiel from the theater back to the United States. Once returned to the United States, the majority of the salvageable equipment required extensive refurbishment due to combat, the harsh desert environment, and shipment by sea (3:7).

Phase II of the closeout extended from mid-August until mid-December. During this phase, the three main activities were withdrawal of materiel from the theater; storage of prepositioned equipment and theater stocks in Doha, Kuwait; and drawdown of provisional units and personnel in theater. Units, including Patriot missile batteries, redeployed from Kuwait to Saudi Arabia as a precursor to their subsequent withdrawal from the theater. Throughout the late fall and early winter, withdrawal of materiel and equipment continued. By 31 December, the majority of supplies, with the exception of ammunition, had been withdrawn and redeployed.

New Agreements

In keeping with a number of new and existing agreements with host Persian Gulf nations, equipment and supplies were moved to a number of prepositioning sites. This prestocked equipment and materiel provided the United States with an exceptional capability to support exercises and contingency operations in the region. In addition, as a result of a new host-nation agreement, a permanent organization—known as the Combat Equipment Group, Southwest Asia—was established in Doha, Kuwait, to manage and maintain prepositioned materiel and equipment stocks. By late October, US Army provisional units began to stand down, with a caretaker command, Army Central Command, forward established to oversee residual operations through at least June 1992 (3:8).

The final phase of the Army's theater closeout consisted of moving remaining ammunition stockpiles to ports or collection points and either shipping it from the theater or destroying it at destruction facilities. The numbers of provisional units and support personnel continued to decrease

until ultimately only the permanent organizations at Doha and Dhahran remained, with all other personnel withdrawn and all other facilities closed. Remaining in theater were several Patriot missile batteries; the US Military Training Mission based in Dhahran and Riyadh; the US Army, Kuwait; and prepositioned stocks of equipment and materiel in Kuwait and Bahrain.

Reconstitution

Efforts aimed at redeploying personnel and equipment out of the theater were begun almost immediately following cessation of hostilities. These activities included preparing materiel for redeployment, shipping the materiel back to home unit locations, and eventually receiving items back at home stations. Once units and the majority of their equipment began arriving back at their US bases, equipment had to be inspected, initial servicing and repairs performed, property accountability established, and supply support activities reestablished. A substantial effort was also required to update unit maintenance management systems to reflect the pressing requirements for beyond routine maintenance required on much of the equipment returning from the theater (9:18).

Even with the eventual return of the majority of US warfighting materiel from the theater, the logistics challenge was far from over. For the majority of the equipment, the exposure to the environmental effects of operating in the arid desert climate of Southwest Asia and of traveling to and from the theater by sea promoted significant degradation of the equipment's readiness for future combat operations. Despite the Herculean sustainment efforts carried on throughout the Gulf War, a major reconstitution effort was required by the majority of participating units. The experiences of the US Army's 1st Infantry Division (Mechanized), the *Big Red 1*, in reconstituting unit readiness and warfighting capability are typical of those experienced throughout the US military following the conclusion of Operation Desert Storm.

Brigadier General James F. Brickman, Commander, 1st Infantry Division (Mechanized), defined post-redeployment reconstitution as:

> . . . those extraordinary regeneration actions that are planned and implemented to restore units to a desired level of combat effectiveness in line with peacetime mission requirements and resources. These actions transcend normal day-to-day force sustainment and require Army-wide support in many areas (9:18).

Managing Excess

Management of repair parts stocks was the first major challenge facing the division upon its return to Fort Riley, Kansas. A factor complicating the management situation, and fairly typical of the problems facing many of the units redeploying from Southwest Asia, was that the division's authorized stock of repair parts was not among the first of the division's shipments to be returned from the theater. Thus, at the very time the division was trying to initiate a major reconstitution effort, it was hampered by the fact the spare parts were somewhere between the port of Dammam, Saudi Arabia, and Fort Riley, Kansas. Division commanders found themselves critically short of some essential items but also buried in excess of others. Ordering additional stocks of repair parts required, in the short run, to replace stocks still in transit from Saudi Arabia quickly turned to excess as shipments from the theater began arriving over several months. In many cases, parts were ordered from the wholesale system when those parts were already stocked in a unit's authorized stocks, although spread out in redistribution channels between the theater and Fort Riley. In addition, the requisition and shipping times required to obtain items through the wholesale system resulted in equipment being *deadlined* for a lack of parts, costing the division a loss of mission-capable days (9:20).

Parts Influx

Over a 3-month period following redeployment from Saudi Arabia, receiving facilities at Fort Riley were inundated by 2-1/2 times their normal daily volume as units requisitioned required repair parts and supplies. A key lesson learned by Army planners was that operating parts stocks should be among the first items redeployed so they will be available to support equipment as it arrives.

Commensurate with this, planners also agreed that elements of the main support battalion should also have been redeployed ahead of the bulk of the division in order to be available to manage equipment and materiel as it arrived back at the home station (9:20).

Units Assume Supply Responsibility

As units began to get their normal supply and maintenance activities back online following redeployment, the potential for a bottleneck at the division level parts supply facility was quickly recognized. To avoid this, receiving activities and parts management were temporarily pushed down to the unit level while excess items were simultaneously processed up and out of the division through the centralized supply activity. Thus, units were instructed to identify, retain, account for, and use repair parts on hand at the unit level until notified to resume normal supply procedures (9:20).

Given the potential volume of unnecessary parts stocks, cancellation of due-in supply excess (orders for supplies that were no longer needed) was a high priority for unit planners. The objective was to cancel excess early enough to prevent unnecessary items from being shipped from the depots and thus save funds. A major supply reconciliation revealed the existence of more than 22,000 requisition documents for parts that had been shipped to Saudi Arabia but not received. From July 1991 through February 1992, 1st Infantry Division (Mechanized) supply personnel canceled orders for more than $60 million in excess due-in parts.

As equipment began to arrive back at Fort Riley, thorough technical inspections to identify spare parts and servicing

requirements were undertaken. Even this seemingly simple task required almost 45 days of virtually around-the-clock operations. The bulk of the division's equipment was in substantially worse shape than had been expected.

Additional Servicing Required

Division equipment had been serviced prior to departure from Southwest Asia, including the required sanitation procedures required to prevent potential agricultural and soil contamination. However, these services were often performed at below standard levels using modified procedures due to the harsh desert environment, unavailability of required parts or supplies, the limited time available for service or, usually, some combination of the above. With this in mind, many service-related repair parts, supplies, and petroleum products were ordered while the unit was still in Saudi Arabia to ensure their availability when the unit arrived back at its home station following redeployment. This forward thinking saved the division significant downtime and allowed a more rapid recovery pace than would have otherwise been possible (10:31).

Equipment Accountability

One of the final logistics readiness challenges facing the 1st Infantry Division was accountability of the unit's real property and equipment. Waste and destruction of property are inevitable consequences of combat. However, modern equipment accountability requirements dictate that accurate inventories be established and maintained. Thus, a substantial effort was required to identify equipment that had been destroyed or lost during the unit's operations in the desert and to adjust reported inventories and accountability documents as required. This seemingly mundane task was of extreme importance to at least some of the division personnel as more than one supply officer was found accountable for several million missing pieces of equipment.

Seldom was such equipment really missing, but its disposition had to be determined, and the assets and accompanying paperwork had to be appropriately reconciled to rebalance supply accounts. As might be expected, some units found themselves with far less than they were authorized while others found themselves far better equipped than when they initially deployed—and than their authorized equipment lists would allow.

The problems involved in achieving accurate inventories were not at all trivial. The fact that the 1st Infantry Division's equipment arrived back in the United States over a period of many months meant no wall-to-wall inventory was actually possible until well into the reconstitution effort. However, once such a 100 percent inventory was actually accomplished by all division units, an aggressive program of lateral transfers and turn-ins eliminated inventory disparities while simultaneously avoiding an overtasking of already saturated central supply functions.

Reestablishing Supply Channels

A final hurdle confronted by the Big Red 1 centered on the need to reestablish normal, non-wartime, supply channels. When it deployed to Southwest Asia, the 1st Infantry Division effectively dropped from routine Army supply channels. As the unit's supply requirements were addressed through the contingency channels that occurred as a part of the Desert Storm sustainment effort, the computerized database the Army uses in peacetime to support all Army units was no longer updated with the division's data. This seemingly minor glitch would, however, result in near chaos once the division was redeployed and attempted to reengage the normal supply system. The inaccuracies in the supply system database, coupled with changes to the system completed while the unit was deployed, resulted in a situation where the supply system refused to recognize the division's requirements. As a result, the wholesale supply system routinely rejected and canceled the division's requisitions. This problem would plague the division's reconstitution efforts for almost a year following redeployment and was overcome only through the use of innovative work arounds at both the Big Red 1 and higher headquarters (10:33).

Returning weapons, such as this M1A1 tank, to their units as quickly as possible was a major reconstitution concern. Official US Air Force photo)

Delayed Desert Damage

Following redeployment from Saudi Arabia, it was readily apparent to the US Army Tank and Automotive Command (TACOM) in Warren, Michigan, that the environmental impacts of Operations Desert Storm and Desert Shield on the Army's tracked and wheeled vehicle fleets were substantially greater than anticipated. In response, TACOM initiated its 3D (Delayed Desert Damage) program to find the full extent and causes of desert-related damage, determine appropriate corrective maintenance requirements, and estimate corresponding man-hour and supply system effects of the increased equipment maintenance requirements. At the onset of the program, a sample of 30 different tracked and wheeled vehicles used in the war were run through extended depot- level maintenance procedures.

Worse Than Expected

Initially, vehicles were run through standard depot inspections as well as normal teardown and maintenance. Depot personnel were then instructed to conduct a more extensive analysis to determine whether normal depot procedures were sufficient to fully detect all hidden damage and maintenance requirements. During the subsequent inspections, depot personnel found more unanticipated damage that would have gone undetected through normal depot procedures.

Most startling were three transmissions that had operated successfully during road tests and passed pre-shop analysis on dynamometers. Further breakdowns of these transmissions revealed sand and corrosion and filtration or lubrication problems had compromised all three to the point of certain premature failure. Clutch plates were worn beyond tolerances due to the presence of sand. Two gears in one of the transmissions were welded together because of the extreme heat generated by contamination.

Extensive depot inspections also revealed road-arm leakage and road arms with large amounts of sand both inside and out. Deposits of sand, dirt, and water were found in brake chambers. The teams found sand in axle assemblies, starters, alternators, and virtually every engine and transmission. Depot and TACOM technicians found in-tank fuel pumps still operating but with sand and dust all over them. Heater boxes were covered with sand inside and out. Various signs of burning, scoring, metal stress, viscosity breakdowns of lubricants, and dilution of fuel with water and sand were almost universal among the sample vehicles (11:25-26).

While TACOM's specific analysis was directed only at the US Army assets under its control, the factors that caused the extensive damage encountered during the depot evaluation were certainly common throughout the Southwest Asian theater of operations. Hence, the other Services encountered similar levels of unanticipated delayed desert damage throughout the Desert Shield/Desert Storm reconstitution process. In fact, given the extent of the potential damage, it is quite likely the full extent of the delayed effects of US involvement in Desert Storm on equipment and materiel was not fully realized for years until those effects showed up as premature aging and deterioration of assets involved in the Gulf War. The Defense Logistics Agency and the US Marine Corps both initiated similar programs to combat the delayed effects of desert theater warfare. The Marine Corps program—*Saudi Arabia Non-combat Damage* (or SAND)—was established at corps logistics bases in Albany, Georgia, and Barstow, California (11:27).

Climate and Operating Tempo

In the final analysis, it is clear that two factors clearly compounded the detrimental effects on equipment associated with desert warfare. First, the ground portion of the war involved a sizable increase in the operations tempo of the equipment involved. Usage rates were from 10 to 40 times the normal operating rate for given vehicle classes within the fleet. This sustained rapid pace of operations would be sufficiently grueling even under optimum conditions but was worsened by the fast moving combat environment of Operation Desert Storm. Second, the extraordinarily difficult terrain, excessive desert temperatures, and airborne sand took its toll on equipment. As US planners learned through experience, the sand in Southwest Asia is much finer than that to which Westerners are accustomed. "It is more menacing. It penetrates. Any breach in seals or filters invites sand to enter" (11:27). In the desert environment of Southwest Asia, filters were often ineffective or clogged quickly. Engines rapidly overheated. Quick fix activities were needed to repair equipment as rapidly as possible before further contamination occurred (11:27-28). An important facet of combat operations that was reemphasized during the 100 hours of ground combat in Desert Storm is well worth noting:

> Clearly, the operational tempo of Desert Storm, compounded by the Southwest Asia environment, stretched the limits of American tank-automotive equipment. One last consideration impacting delayed desert damage is the fact that, as the operational tempo went up, maintenance decreased (11:27).

Although Desert Storm was a short war, the materiel degradation was substantial. The implications for sustained logistics and combat operations over a span of months versus the 100 hours of actual ground combat in Desert Storm should signal a clear message to logistics planners: maintaining equipment readiness in adverse climatic conditions will require a total logistics effort, an effort that will tax both the sustainment and retrograde systems to the utmost.

Desert Sweep

When hostilities ended, a major challenge facing coalition allies and the nation of Kuwait was disposing of munitions remnants of the desert war. The war left literally millions of tons of unexploded mines, aerial bombs, and submunitions littered in the Kuwaiti desert. In addition, immense stockpiles

of salvageable munitions, thousands of inoperable tanks and trucks, and abandoned bunkers and revetments were scattered throughout the theater. The danger from these wartime leftovers was very real indeed; the Kuwaiti government estimated that as of 13 October 1992 more than 1,500 civilian casualties had occurred as a result of the deadly litter left after the Iraqi occupation and the subsequent allied offensive (12:4).

To return the desert to its pre-invasion condition, Kuwait requested allied aid and divided its territory into seven sectors. Seven allied countries that took part in the war were then requested to each clear a sector, under contract to the government of Kuwait. These countries—the United States, Great Britain, France, Egypt, Bangladesh, Pakistan, and Turkey—then set about the dangerous task of clearing the desert within their respective sectors. Countries like Egypt chose to use military personnel to accomplish the dangerous task in much the same manner ordnance has been cleared since before World War II. Others, including the United States, contracted the clearing effort to private companies.

Contracted Support

Within the US sector, Conventional Munitions Systems, Inc (CMS), was selected to clear the 1,207 square miles of desert, including 55.2 square miles of minefields. By way of estimates, it is believed a third of the approximately 100,000 tons of explosives dropped by the allies over Kuwait never exploded, either because they were duds or were swallowed by the sand (12:4). CMS vice-president for planning and coordination, Alfred L. Dibella, Jr, conservatively estimates that more than 1 million dud submunitions from Rockeye aerial bombs littered the US sector alone (13:54).

Deadly Litter

Dibella believed at least 100,000 tons of Rockeyes were dropped during the war, with each Rockeye containing at least 250 submunitions. That means 25 million bomblets were dropped by allied aircraft "with a dud rate of 5 percent, which is a very low estimate. There were at least 1,250,000 unexploded Rockeyes in the desert" (13:54).

The presence of such a vast quantity of unexploded ordnance in the desert forced US personnel on seemingly less dangerous recovery and transportation missions to be routinely accompanied by expert explosive ordnance disposal (EOD) personnel. The presence of undetected munitions was a major threat to US logistics personnel working to retrieve assets from the desert. In fact, the presence of munitions, combined with already hazardous desert terrain, made some areas inaccessible (14:14).

Mines and Other Dangers

Munitions dropped by coalition forces were not the only hazardous obstacles facing CMS and its crews. Iraqi forces laid an estimated 500,000 mines in 16 different varieties within the borders of Kuwait during their 17-month occupation of Kuwait.

Mine clearing the old-fashioned way. This was one of many ways used to find and remove mines at the conclusion of the Gulf War. (Official US Air Force photo)

Iraq seeded the desert not only with antitank and antipersonnel mines of its own design but also with varieties manufactured by Italy, Belgium, Russia, China, Czechoslovakia, Great Britain, and Pakistan.

Fortunately, CMS personnel found their already dangerous work was not complicated by Iraqi booby traps (13:54). However, exposure to the elements has caused many munitions to become unstable. One US technician, a former EOD instructor with more than 20 years' experience, was killed when an artillery shell exploded unexpectedly under routine handling (12:4). More than 50 sappers, as the EOD technicians are known, were killed in Kuwait during the cleanup effort. Dozens more were seriously injured, including Kuwait's entire five-man EOD team. "This stuff is very unforgiving," said Floyd D. Rockwell, a retired US Army master sergeant now serving as a disposal technician with CMS (12:4).

In addition to the rigors of removing leftover ordnance, sappers and laborers working near the Iraq-Kuwait border often had to deal with hostile Iraqi border patrols that routinely fired over their heads as the crews conducted their ordnance sweeps. One US technician, Clinton A. Hall, was taken prisoner by Iraqi forces for 3 days in early October when his duties carried him too close to a roving Iraqi patrol (12:4).

New Technologies

CMS personnel used a variety of state-of-the-art systems to clear ordnance contaminated areas. They used the Navstar/Global Positioning System (GPS) to precisely pinpoint and survey minefields, munitions caches, and other contaminated areas. Most of the Iraqi minefields were laid in precise patterns so mapping was relatively easy once the areas were located. Rockeye bomblets, however, were widely and irregularly dispersed so the task was more difficult. Using the GPS, technicians plotted ordnance locations using an eight-digit grid code that told which EOD team located the ordnance, the sector in which they were located, type of ordnance involved, and approximate number of each type. The 26 GPS receivers and plotting system used by technicians to precisely mark

and plot dangerous areas were part of a program known as the minefield and ordnance recovery system (13:54). Once mines or bombs were located, they were disposed of by a variety of means depending on their type and general location.

Air-delivered munitions such as Rockeye bomblets were generally destroyed in place, but CMS investigated the idea of using robot sappers to collect the unexploded ordnance for delivery and destruction at a centralized site. Minefields were originally cleared by blowing up the mines in place. This practice proved unsatisfactory, however, as detonations tended to cover nearby unexploded mines with sand displaced by the explosion. Mines were subsequently manually disarmed, collected, and moved to a central destruction site for disposal (13:55).

Locating mines was made easier by CMS' adoption of a state-of-the-art 13.4-pound, handheld metallic mine detector as a replacement for the US Army's vintage standard detector, which had seen service for more than 30 years. Ground-penetrating radar capable of detecting munitions up to 8 feet below the surface and airborne and space-borne synthetic aperture radar were also used to scrutinize the region for hazards (13:55).

The sheer volume of unexploded ordnance available made the Kuwaiti desert a virtual laboratory for development and evaluation of new and refined EOD techniques. Concentrations of Rockeye submunitions were destroyed using a foam substance that hardens on contact and becomes explosive as it hardens. Binary liquid explosives sprayed on contaminated areas that form an explosive slurry of sand and munitions were also used (13:55).

Captured Ordnance Stocks

Not all the munitions found in the desert were duds. In addition to thousands of smaller caches and ammunition dumps scattered throughout the desert, at least five Iraqi underground munitions storage sites were discovered. Containing a total of 1 million tons of serviceable Iraqi munitions, these sites were carefully salvaged and used to augment Kuwaiti military stockpiles (13:54).

The job of cleansing the desert of its deadly litter was an enormous task. The $134 million contract was expected to keep CMS and its employees busy for 5 to 7 years. One of the problems that extended the cleanup effort was the inaccessibility of areas located under the large oil spills created when retreating Iraqi forces set the Kuwaiti oil fields ablaze.

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Prologue

The end of the cold war and experience gained from the conflicts described in this book essentially brought the era of *brute force* logistics to a close. The traditional practice of using massive quantities of troops and large stockpiles of supplies available in theater to engage sizable hostile forces is obsolete. Additionally, extensive buildup time and lengthy resupply and repair pipelines to sustain forces are unrealistic. Military operations in Grenada, Panama, and the Persian Gulf demonstrated the need to reevaluate the way the US military deploys and sustains its forces. Therefore, the focus of logistics now shifts toward rapid movement of small, independent force packages to employ precise combat power anywhere in the world. This revolutionary change is due to many influences. The rapid change in political dynamics of the world powers, domestic fiscal constraints, and technological advances have rendered the Cold War military strategy and preparation ill-equipped to handle future missions, requirements, and demands.

The US role in the post Cold War world has changed dramatically. Military forces are no longer dedicated solely to deterring aggression. They must respond to and support a variety of combat and humanitarian missions. From peacekeeping, to feeding starving nations, to conducting counter drug operations, the military continues to adapt to evolving missions. Logistics infrastructure and processes must, therefore, evolve to support the new spectrum of demands. The key to successfully supporting future combat operations is creating robust, responsive, and flexible logistics systems within current budgetary constraints.

Decreases in funding and the drawdown of the US military continue to force new approaches to logistics support and refinement of the military logistics system. In the post Cold War era, the budget for the Department of Defense has declined from approximately $360 billion to $250 billion (in 1996 dollars). These fiscal constraints dictate that the military must reduce infrastructure, maintain smaller numbers of both inventory and personnel, and find ways to reduce costs without degrading mission capability. The impact of these constraints may be mitigated by use of new technology.

Reduced budgets impact weapons modernization programs. As dollars decrease, fewer new systems can be developed, which increases the importance of decisions made in the acquisition process. The process must develop the most lethal systems while emphasizing reliability and supportability. Therefore, logistics considerations play a more important role than ever in the design, production, and fielding of new systems. Logistics capabilities for supporting future forces require systems to be *smarter* and require less maintenance. This includes designing self-diagnostic systems and ensuring systems and components are reliable enough to decrease the need for spares purchases.

Technology not only affects the development and sustainment of weapons systems but also offers the opportunity to modernize the information infrastructure. This will facilitate joint operations, provide timely access to data, and enable electronic interface to the commercial sector. Information technology will improve the ability to see, prioritize, and assess information. Improved intelligence gathering and in-transit visibility are just two of the capabilities that must be maximized in the development and enhancement of information systems. The integration of information systems will allow for real-time visibility of data, enabling decision makers to act upon current, accurate information. Giving proper attention to information systems will improve the ability of the logistics community to support modern concepts.

Combat operations in the 21st century will require highly responsive and agile forces. One logistics concept designed to maximize agility is time-definite resupply. Under this concept, resupply for a deployed force begins immediately upon arrival, reducing the initial footprint and airlift requirement. Needs of the deployed forces will be met through reach-back to the Continental United States. The concept of lean logistics is in keeping with this approach. The tenets of lean logistics create a system whereby the needs of a deployed force will be met by responsiveness of the logistics pipeline in lieu of large stocks of spares. Another initiative that will have deep-reaching impact on military logistics is outsourcing and privatization (now referred to in the Air Force as competitive sourcing and privatization). There is potential to outsource or privatize a large segment of the military logistics role, but the lasting effects of these decisions is yet to be seen. The future success of logistics depends on continued flexibility in adapting to evolving military strategy, fluctuating domestic fiscal constraints, and emerging technological advances as we enter the age of Agile Combat Support.

A BRIEF REVIEW: 1935-1985

History of US Military Logistics

Introduction

US military logistics history is filled with tales of success and failure. Both should be expected of such large-scale endeavors over so many years. There are available many stories of great interest that might be classed as *war stories* and masses of statistical data of all kinds. In this text, we will use some of both, in addition to the historical narrative, because both tell of important facets of military logistics. Throughout the text, though, we will attempt to relate the problems faced by military logisticians and the solutions they derived in their efforts to succeed in supporting the combat forces so they might achieve the sought-after victory.

In our review of military logistics history over the last 50 years, we will not rely on names, dates, and specific facts of the past unless that information is essential. Since they are vital elements of history, they cannot be entirely avoided. However, the intent of this text is to relate the history of military logistics in a meaningful and interesting manner without filling the pages with numbers and names. The reference notations and bibliography can lead the interested reader to a source of additional details that might serve to satisfy a thirst for more knowledge.

The history of US logistics, its failures, and its successes is based upon the deeds and actions of thousands of people of various ranks and grades whose names are not and were not recorded. In truth, they were the *makers* of logistics history even though the major decisions might have been made by the often more famous names. Logistics capability and capacity came only because these lesser known people did what had to be done with great skill and with dedication to the military mission at hand. The United States has succeeded overall and survived to this point in time because these unsung heroes of logistics did their jobs well regardless of environmental and psychological constraints. We cannot and will not attempt to relate in detail how all these jobs were done. The point to be made is that huge needs existed and were met by these great people doing their jobs and, often, a lot more. The challenge was met and the obstacles overcome. We, in logistics, should be proud of our accomplishments of the past, but we should also be dedicated to learning from those accomplishments. That, then, is the principal reason for this text.

Military history has long ignored logistics. No one wrote about and no one remembers the original logistician. He was probably a mean but smart Neanderthal (or earlier) warrior who spent some time thinking about conditions and began to stock stones, arrows, and spears in logical places for a coming battle. Chances are very good that he won the battle, but we will never know since history doesn't tell us. Many people study the strategy and tactics of great battles, but few study, and even fewer learn of, the logistics actions that contributed so greatly to the outcome of those battles.

Lieutenant General Brehon Somervell in 1944 said, "History has little to say of the great logisticians, for the prancing charger is longer remembered than the pack mule." How true. Because logistics lacks *sex appeal,* it finds little coverage in military history or education. It certainly never approaches the dramatic and flowery coverage accorded strategy or tactics. And the published biography of the logistician is extremely rare.

If the nation is to escape or even minimize the blunders of the past, it cannot neglect to study its mistakes (112:ix). Therefore, we must recognize that, for logisticians, the study of military logistics history is vitally important because of the nature of the problems faced by military leadership. The study of military logistics history will help the logistician and the student of logistics to more readily identify current problems, and it will suggest potential avenues of solution for those problems. Further and perhaps far more important, the study will help logisticians create more effective logistics systems for tomorrow. This text cannot be a substitute for more in-depth study, but it can provide a base for the dedicated person to work from.

Addressing the theme of US preparation for war prior to World War II, the Final Report of the Army Service Forces, July 1947, concluded:

> For the most part, Army schools and the War Department General Staff in peacetime planned, trained for, and studied combat operations. To a great extent the Army neglected the logistics problems of operations. This was a deficiency that proved to be costly (297:159).

In a speech before the 1912 Conference on Military History, former President Theodore Roosevelt said the study of military history was extremely important. He indicated that he thought intelligent study of military history might have improved the caliber of some of the officials with whom he had worked as Assistant Secretary of the Navy, as a colonel in a voluntary cavalry regiment, and as President of the United States (8:184).

Former President Harry S. Truman said that reading history was, to him, far more than romantic adventure. It was, he said, solid instruction and wise teaching (237:119). I hope this text proves thus for you, the reader.

We must be cautious about one important factor. No matter how well done the research or how carefully conceived the writing, we can never be completely certain and we can never be in complete agreement about what actually happened in the past. None of us can fully and faithfully recall impressions or perceptions or emotions that led to certain decisions. Particularly is this true for the writer who might not have been present at the event or the place of decision. Yet the decisions were made and the acts accomplished—history did occur. How was it seen? How was it recorded? The human mind just cannot

recreate the events of the past exactly as they occurred. Though I have been careful to ensure factual reporting, there may be reasons for disagreement with what is stated. Let there be. Just don't let there be apathy.

This book is chronologically organized to briefly present US military logistics history from 1935, the time just before the beginning of World War II (September 1939), to 1985. In this brief recount of events, not everything can be covered. Topics and events have been selectively chosen to give the greatest overall view and understanding of the history of military logistics. In the coverage of the combat eras (World War II, Korea, and Vietnam), the focus is on the role of logistics directly supporting combat efforts.

What do we mean by *military logistics*? I define the term as follows: logistics is a system established to create and sustain military capability.

Many definitions of logistics exist. There is much argument about the definition in various journals, magazines, and books. I have found this straightforward definition works well for my needs. Accordingly, in describing the logistics environment and the logistics system, I will include almost everything short of actual combat. Certainly, logistics must include manpower and personnel factors (such as feeding, hospitalization, and so forth) as well as the more commonly considered factors of hardware and weapons systems, requirements determination, acquisition, distribution, and conservation. And then, we must accept that construction of airfields, ports, bases, and other facilities certainly has much to do with creating and sustaining military capability so that, too, is part of the logistics. Nothing gets done today without money so we must also discuss budgeting, accounting, and finance in the logistics system. The point is, we will be relating to most of the military service activity as we review military logistics history.

Admirals Carter and Duvall, in their fine 1954 book, *Ships, Salvage, and Sinews of War*, stated:

> The term "logistics" involves a vast scheme of plans for men and things needed to build, support and maintain fighting forces wherever they may be. The various phases of logistics are almost limitless and concern activities extending from farm and factory to shore stations, shipping centers, and ships in the combat zone (36:ix).

Fleet Admiral Nimitz is quoted in that book:

> Logistics is an all-embracive term that touches every producing activity at home. It commences with the farmers, miners, all other producers of raw materiel, and includes all the processors of foods and materiel such as ship builders, munition makers, and the like (36:ix).

His statement was longer, but the point is made with this short section—military logistics includes all effort, other than the combat troops themselves, involved in creating and sustaining military capability. I hope the reader will bear this in mind as the text is read. If it is not, there may be much wonder about why certain material was included.

I enjoyed researching and developing this text. I learned a great deal as a result. I hope you do also, and I hope you enjoy the process of reading and studying US military logistics history: 1935-1985.

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Chapter One

Logistics Environment: Pre-World War II

1935-1941

The period between world War I and World War II was a time of mixed events and signals for the United States, its people, and its military forces. World War I had been fought and won. It was considered the war to *make the world safe for democracy* and led the American populace to generally feel no further wars would or should be fought by American soldiers and sailors. A cycling national economy brought times of elation followed by times of financial trouble. The 1920s saw considerable labor difficulty as labor unions struggled to find their place and make their mark. Ethnic and racial problems surfaced in many parts of the country. There was worry about the developing morality of the population. It was a time of concern for many people.

In general, the attitude of the people in the 1920s signaled no need for a standing army or navy of any size. After all, the United States had no enemies. Further, the country had the good fortune to be geographically sited with two large oceans separating it from potential invaders. We had no probable worries about Canada's intentions on our northern border or Mexico's on the southern. That *two-ocean separation* indicated to many that all we needed was a small military, spending small sums annually, principally to defend the continental United States. Political and military disagreements in other lands were not the business of the United States, and we should not be involved in such activities. Thus, no military strength was required for possible foreign deployment from our shores. Congress and the people noted the activities in other countries but generally felt those activities not to be threatening to the immediate or forecast security of the country.

The Depression

In October 1929, the bottom dropped out of the economy. This was represented by the stock market crash. The factors causing the economic collapse were many. Among them were overproduction of goods, curtailment of foreign markets through national policies, and easy money policies that caused credit expansion beyond repayment abilities and unsupported speculation on the stock market. The resulting *Great Depression* spread to most of the countries of the world. All were somehow involved. Thousands of businesses ceased to exist, and with them went hundreds of thousands of jobs. As greatly reduced incomes took hold, spending dropped, and further unemployment came. As individuals, we had little money, and our federal treasury seemed to have little money for the country. What little we had could not be spent on unnecessary actions or purchases, such as munitions or weapons for the military. Rather, the need was defined as social to help the citizens of our country. The annual budgets for the War Department and the Navy Department were small as Congress voted very low budgets for military affairs in the early 1930s.

The military bought very few supplies and materiel during this time. Great dependence was put on the World War I residue on hand and on the prevailing belief war was no longer likely for the United States. The mood of the country affected the military personnel as well, and there was inadequate planning for or preparation for possible war. The low state of military capability and readiness seemed to meet the approval of the Congress, which did little to challenge or change it. There was no political impetus for research and development funds for military weaponry or equipment. In fact, President Coolidge is reputed to have said, when considering War Department and Navy Department budget requests for aircraft, "Why don't they buy one airplane and let the aviators take turns flying it?" Therefore, in the 1930s, we had only third-rate military forces and no public opinion that this was faulty reasoning.

In the 1930s, there was concern about the increasingly belligerent activities of Japan in the Far East but not enough concern to initiate military preparation. Japan had shown growing militarism and acted against neighboring countries. It was obvious her military strength was increasing, yet many people, concerned though they might be, thought she would restrict her strength tests to the far reaches of the Pacific and never attempt action against the United States.

The Navy recognized the possibility of conflict with Japan in the middle to late 1930s and began unilaterally to plan for supporting a possible Pacific war. Naval planning visualized a sizable fleet. That fleet would be maintained logistically by the bases that currently existed, aided by a fleet of supporting ships. The support ships would be acquired by special funding or by taking over Merchant Marine bottoms then in operation. The Navy thought the United States would have to capture a

few small atolls for advanced naval bases but no serious consideration was given to a vast, far-ranging network of harbors and bases around the entire Pacific basin. No apparent effort was made to coordinate this planning with the Army or the War Department. This singular action of the Navy probably came about because the planners and their superiors thought there would be, as always before, clear and defined demarcations for the operations and responsibilities of the two military departments. Each department generally proceeded with its own independent effort. The few joint boards and commissions established in the late 1930s did little to alter these conditions.

During the 1930s, with the overall low military budgets, all things were hard to get. Even so, logisticians, in cooperation with operations personnel, succeeded in solving some vexing and life-threatening problems. For example, in Panama the aircrews were often required to fly over very thick jungle, which made an emergency landing impossible but a controlled crash likely if the aircraft did go down. If so, the crew faced many problems with bug bites, poisonous snakes, cuts and wounds, and extremely heavy undergrowth they would have to somehow work their way through if they were to get out alive.

The *Air Corps Newsletter*, Volume XIX, No. 12, 15 June 1936, reported on the action. The Air Corps people in Panama devised an emergency kit (which was manufactured by the engineering department of Scott Field, Illinois), which they fitted to the parachute. The kit replaced the air-inflated seat cushion of the *chute* and was constructed to serve as the cushion. The kit contained:

- USA Corps of Engineers prismatic compass.
- Bolo knife (machete).
- Mosquito headnet.
- Waterproof box of matches.
- Waterproof box containing iodine (1/4 ounce) and a small bottle of quinine.
- US Army pistol, .45 caliber with ammunition.
- Two pounds emergency rations in waterproof, airtight wrap.

All this materiel came from existing supplies but, apparently, not from surplus. Thus, this usage created shortages elsewhere.

The Roosevelt Program

Franklin D. Roosevelt was elected President of the Untied States and assumed office in 1933 with a vision for a *New Deal* that included much legislative action to assist the people. It must be remembered the country was in the depths of the Depression and unemployment was soaring. His initial actions included telling the country, “The only thing we have to fear is fear itself.” His first months have come to be known as *The First Hundred Days,* and they saw a barrage of legislative requests for fiscal and social reforms from the Congress. All were aimed at reviving the ailing economic state and involved vast expenditures of public money on a variety of programs.

The programs included the National Industrial Recovery Act (NIRA) and under it the National Recovery Administration (NRA) with its famous *Blue Eagle* symbol; the Public Works Administration (PWA); the National Youth Administration (NYA); the Civilian Conservation Corps (CCC); and Social Security. The latter is about the only of these efforts to continue to function through the middle 1980s.

The Congress passed the National Industrial Recovery Act in 1933, and the National Recovery Administration was established to administer it. The objective of the NIRA was to create jobs for Americans. Roosevelt assured the public that under the NIRA the federal government would become a partner with business and industry as they worked together to revive the economy. Business and industrial managers could form trade organizations and develop their own rules of conduct. However, if they could not agree, the government would impose its own codes. Antitrust laws were suspended by the NIRA, and business and industrial managers were challenged to replace competition with cooperation.

The NRA established more than 500 industrial fair practice codes, which included:

- Minimum salaries ($12 to $15 per week, to start).
- Work hours.
- Health and safety conditions.
- Hiring and firing practices.
- Severance pay procedures.
- Collective bargaining
- Union organizing.
- Procedures for choosing labor representatives.
- Elimination of child labor.

On 7 January 1935, the Supreme Court invalidated some of the codes as unconstitutional. Then in late May, the Court ruled other elements of the NIRA were unconstitutional. The Court said the codes were laws, and the Constitution did not permit the Congress to pass its lawmaking authority to other branches of the government. Nevertheless, the codes served a purpose, and many continued in use and persisted through contracts between labor and management.

Included in the NIRA was $3.3 billion for public works projects. This was directed toward creating jobs for the unemployed and stimulating the economy with spendable income. There was considerable unrest among labor and the unemployed. That unrest seemed to be encouraged by the NIRA provisions supporting union activity and seemingly encouraging labor to resist management. However, the Public Works Administration, created under the NIRA, did pretty much what the Act intended. Its projects were large efforts that met real needs but were more capital intensive than labor intensive. Some of the PWA projects were:

- Jefferson Memorial in Washington.
- Pan-American Building in Washington.
- Golden Gate Bridge in San Francisco.
- Grand Coulee Dam in the Columbia River.

- Triborough Bridge in New York City.
- Queens-Midtown Tunnel in New York City.
- Slum clearance in many major cities.
- Federal housing in many cities.
- Public buildings such as post offices and libraries in many sites.
- Military buildings such as the brick quarters on Wright Field, Ohio (221:840-1).

The Congress passed an act establishing the Works Progress Administration (WPA) in April 1935, and Roosevelt asked for and received $4.8 billion for its initial efforts. The WPA projects were labor intensive with the target being putting people to work to relieve Depression problems. Over time, the WPA created the talking books for the blind, taught illiterates to read, provided job training, and much more. The initial money went to the following:

- $800 million highway and grade-crossing construction.
- $500 million rural irrigation and reclamation projects.
- $450 million housing construction.
- $800 million rural electrification.
- $300 million aid to education.
- $600 million Civilian Conservation Corps.
- $1.350 billion reforestation, erosion, and flood control projects.

Later, in 1939, in an apparent misuse of funds (which was not seriously challenged), Roosevelt used WPA money to build aircraft carriers and aircraft manufacturing plants. All of this later turned out to be extremely helpful, of course, as the pressure mounted to assist the British in their war against Germany and to improve the military capability of the United States.

The National Youth Administration (NYA) was created in June of 1935 to assist young people with employment. The basic intent was to keep the families together and the youth in school. Much of the NYA effort was expended in high schools and colleges providing part-time jobs for the young students. The jobs, usually paying no more than 25 cents per hour, were assistants to teachers or professors, laboratory assistants, and the like. It was effective and helpful.

Roosevelt signed the Civilian Conservation Corps into law on 31 March 1933. It functioned effectively until overcome by World War II when the Congress discontinued it in 1942. The CCC was the most popular and accepted of all the New Deal efforts. Its purpose was Depression relief through aid to young unemployed men by way of projects to conserve and develop the country's natural resources. The intent was to have 25,000 men in the CCC in 4 months. The original 2,500 men had to prove they were destitute and unemployed, although later the recruitment was not so stern. The first camp was established at Luray, Virginia, but ultimately there were 2,600 CCC camps across the United States. Following the stresses of the time, the camps were segregated with separate camps provided for black and white CCC units.

The camps and the CCC were operated as quasi-military organizations. The camp commanders were reserve officers recruited for that purpose. They had military backgrounds, and there were no other sources for the types of abilities needed. All CCC members wore uniforms of forest green with shoulder insignia and overseas cap. They received $30 per month plus food, lodging, and medical care. However, they received only pocket money with the bulk of the monthly pay going to their families. The CCC peaked at 50,000 men, but approximately 3 million participated in the experience over its 9-year life.

A leadership training camp was created in 1940 at Sharon, Vermont, to train CCC members for later employment in leadership positions. The leadership training had a short life, though, as it ended with the beginning of the military draft that fall. However, the CCC created a pool of manpower with good backgrounds for later military service. Further, the program was of great assistance to the members and their families, and it did a great deal of good for the country. For example, a partial listing of the CCC accomplishments would include:

- 97,000 miles of park roads constructed.
- 89,000 miles of telephone lines installed on federal lands.
- 6,459,000 man-days fighting forest fires.
- 1,356,000,000 trees planted (68:24-27).

The Military Forces

A few people thought it wrong for the country to slide into an almost defenseless condition. They spoke up but were not able to influence the needed change in or for the military. The Secretary of War and his assistant publicly disagreed about the fortunes of the War Department. The Secretary accepted the existing conditions. The Assistant Secretary urged rearmament and a strength buildup, first as a means of moving some elements of the economy and, second, as a means of ensuring peacetime through strength. The Secretary, as might be expected, ruled, and the military received little added support even though these public disagreements continued.

The result was a military force of small size, inadequate training, and low-quality weaponry. In mid-1939, the United States had 189,839 men in the Army, 125,202 men in the Navy, and 19,432 men in the Marine Corps, for a total of 334,473 (94:422). In addition, we had approximately 200,000 potential military personnel in the National Guard (140:21). When the National Guard and the Regulars went on maneuvers in 1939 and again in the spring of 1940, many of them carried broomsticks for rifles, used mortars simulated with stovepipe sections, operated old trucks labeled as tanks, and towed telephone poles or logs carrying signs identifying them as cannon or other artillery pieces. The Air Corps had few practice bombs and in some instances found itself dropping paper bags of flour on the maneuvering infantry troops.

The conditions of that time led to some ridiculous situations in the military. These conditions created considerable resentment among the conscripted troops, who continuously

complained about poor or inadequate training and poor leadership. The situation in 1941 might be best illustrated by the following quotation from an interview with Lieutenant General William R. Desobry included in Kennett's book:

> When it came to learning road marches, the Tank Battalion would go out on a road march without tanks. You would see a five-guy tank crew marching down the road and fifty yards behind them more guys walking down the road. They represented tanks and they kept their inner walls and issued orders as if they were in a tank. When they came to a crossroads and they wanted to turn left, hell, they would give the arm signal and turn left (129:85).

A few of the total military personnel were stationed outside the continental United States. These numbered about 60,000 men at sites in Hawaii, the Philippines, Alaska, Puerto Rico, and Panama. All of these persons suffered from inadequate training funds, insufficient munitions, scarce motor transportation, and so forth. In fact, many of these people had very little opportunity to live-fire the weapons for which they were responsible because there was not enough ammunition for such training. We had an Army and Navy in name only, in many respects.

The 1930s and Japan

In light of later events that dragged the United States into war with Japan and Germany, it is worth a few lines to examine Japan in the 1930s. If we bear in mind the definition of logistics presented earlier, much of this information may seem to fall within the range of that definition.

In the 1930s, most of the Japanese people were struggling to exist. Japan, an island nation a bit smaller in area than California, housed a population of about 80 million. Most families were impoverished and barely able to eke out a living. While the people were fertile and the population was growing by almost 1 million a year, the land area was not growing. Much of Japan is mountainous, and by some estimates, almost three-fourth of the land was not arable. It was evident that Japan ranked at–or near–the top in population density in the world. The Japanese industrial base was constrained also. Most of the countries of the world had enacted restrictive tariffs that prevented a strong industrial economy through Japanese exports. The whole world was suffering a massive economic depression, thus limiting purchasing power for Japanese products. Most constraining was the almost total dependence by Japan on foreign industrial resources. Japan was—and is—a resource-poor country since practically no essential raw materials are available in the country itself.

The conditions of the Japanese did not seem to improve over time. There were strong feelings among many of the military and civilian leaders that some share of the resource riches of Asia rightfully belonged to Japan. Further, many government officials felt a demanding need to somehow obtain more land for the growing population. Most determined were the military officers, particularly the younger ones. Much of the civilian population seemed to agree with the younger, more strident officers of the army and navy.

Their strength grew as the younger officers grew tired of the slower efforts of their elders. They began to act independently to force the Japanese government to take action to correct the dissatisfying conditions. In 1931, for instance, young officers attempted a coup aimed at permitting the army to assume control of the country. The coup was not successful, but it served to inform the country—and the world–of the potential problems building among military officers.

The Japanese Army had been in Manchuria since 1905 to protect and preserve Japanese business in the area. Their presence was maintenance with the general approval of the Manchurian government. However, in late 1931, they grabbed control of Northern Manchuria. This seizure was not an action of the Japanese government but an independent and singular act of the army. The army paid no attention to the orders from Tokyo to stop the activity. Unable to halt the effort, the central Japanese government accepted the condition and officially declared Northern Manchuria part of Japan. Japanese civilians were even encouraged to leave their homeland and migrate to northern Manchuria. As many did, the rest of the world expressed shock, but no nation initiated effective action to stop the takeover.

In 1936, army forces put the national government buildings in central Tokyo under siege and attempted to assassinate the members of the cabinet. This time, the emperor reacted, ordered the troops back to their barracks, and directed trial of the leaders. The leaders were found guilty of treason and were executed. This did not resolve the problems of Japan—it merely slowed events.

In July 1937, Japan attacked China, and soon the magazines, newspapers, newsreels, and radios of the world were relating accounts of atrocities. There were numerous reports of massive pillaging, rape, arson, murder, mass killings, and murders of children. Some small babies were reported to have been slain by being thrown into the air and caught on the bayonets of the Japanese troops. Still, the world did little or nothing to stop the efforts of the Japanese. By the end of 1938, Japan controlled most of China's major cities and almost all the coastal areas. Chinese leaders, Chiang Kai-shek and Mao Tse-tung, holed up in China's interior and continued to resist the Japanese as best they could. They had little logistics support and received little or no help from the outside world.

On 12 December 1937, the Japanese, with no obvious provocation, attacked and sunk the *USS Panay,* a gunboat, at anchor in the Yangtze River above Nanking, China. The *Panay* was clearly marked as a US Navy ship, yet Japanese aircraft bombed and strafed it until it sank. The crew, escaping in rafts, were strafed, and 40 people were wounded. The United States complained to Japan, and eventually the Japanese government paid $2.2 million as *settlement in full* for the atrocity. While the incident aroused the United States, it did not cause any immediate or extensive efforts to improve our military capability or readiness.

The pressure for expansion and the desire for a share of the riches in Asia continued to mount with each Japanese

success. On 27 September 1940, Japan signed a pact aligning itself with Germany and Italy. The Japanese began to pressure the Dutch for a greater portion of the East Indian oil and pressured France to permit Japanese troop to occupy areas of French Indochina (Vietnam). Resistance by the Dutch and French was negated when the Japanese sent troops ashore at Cam Ranh Bay and occupied Saigon and DaNang. Effectively, they began to control most of Southeast Asia.

In mid-1941, the United States acted when President Roosevelt applied an embargo on oil shipments Japan. A similar embargo was placed on cotton and cotton products, scrap iron, and a number of other commodities. Further, he froze Japanese assets in the United States so the Japanese could not retrieve cash, investments, or holdings. Shortly after this action, Britain and the Netherlands applied identical embargoes. Japan became even more belligerent as a result of these actions. From all of this was built the base upon which the Japanese military planned and prepared for the attack on the United States. Ultimately, this resulted in the attack on Pearl Harbor and the Philippines and the entry of the United States into World War II.

US Neutrality and the World

In April 1935, Congress, attending to the mood of the citizenry, passed the Neutrality Act. This very strict law forbade financial aid to any country involved in war. Further, it stated there would be no US protection for American citizens entering a designated war zone. If they entered such an area, they were on their own. This provision was contrary to what had been the policy of the country to this point. The law was slightly modified by the War Policy Act of 1937, which permitted the President some leeway and discretionary powers. However, the 1937 modification affirmed the strict neutrality of the United States and forbade the sale of any form of war materiel to a belligerent nation. These laws later caused President Roosevelt to use various ruses to assist the Allies in their early military actions against the Nazi forces in Europe and the Middle East.

By April 1939, the mood of the country was evidently shifting. A poll conducted by the American Institute of Public Opinion asked, "What do you regard as the most important problem before the American people today?" The responses cited two predominant problems: lack of jobs (36 percent) and possibility of war (37 percent) (129:19).

The Depression was still bothering people. Unemployment was very high. Many people had become nomadic as they roamed the country searching for work—even if for only a day. Congressional actions creating the *New Deal* had begun to show results, but the idle millions were worried about how they might support themselves and their families. Labor laws had established the minimum wage at 40 cents per hour in mid-1939, but the government's figures indicated that more than 10 million were still unemployed.

The world again was again exposed to the fires of war when, on 1 September 1939, Germany began its European expansion with the invasion of Poland. People in the United States now began to sense a more real threat, but still they felt the comfort of the Atlantic Ocean separation. No serious thought was even given to the initiation of military action against the United States by Japan at this time. Nevertheless, President Roosevelt declared a state of limited emergency and authorized the Army to increase its manpower to 227,000 and the National Guard to 235,000. He also obtained authorization to call reservists to active duty. However, the increased manpower authorization did nothing to alleviate the shortage of weaponry. At this point, the Army possessed only about 10 percent of its required 75-millimeter cannons and 1 percent of its 37-millimeter guns. The Air Corps had approximately 1,800 airplanes, but only a small quantity was of modern type and design (140:31).

In accordance with prior agreements and in reaction to Germany's attacks, England and France were immediately engulfed in the war. On 3 September—accompanied by India, Australia, and New Zealand,—they declared war on Germany. Within days, South Africa, Canada, and others followed suit. Within the confines of the strict US neutrality laws, the Allied countries began to place contracts for military goods with American manufacturers. Congress, recognizing the growing conflict, acted to increase budgets for American military needs. The industrial base of the country began to awaken from its long Depression slumber. Yet, the prevailing mood in the country was that the war in Europe was not *our* war. We needed only to provide for our own defense and aid our friends to the extent possible within our laws. Beyond that, we had no goal.

After Germany invaded Poland on 1 September 1939, orders for armaments and military supplies from Britain, France, and the Allies caused some long-closed industrial plants to reopen or expand activity to meet the new orders. Jobs began to be available, and personal incomes began to rise. People now could say, for perhaps the first time in years, they had a few coins to shake in their pockets. Thus, with the new jobs and the awakened economy, weaponry lost some of its evil reputation, and people began to think a bit more rationally about the US military forces. There was little publicity and apparently not much notice when Roosevelt, on the advice of Albert Einstein, established the Advisory Committee on Uranium, indicating that some research was underway. Very few understood this, and not many seemed to think it either good or bad.

The war was going badly for the Allies in Europe. Action in the United States altered the Neutrality Law by allowing a cash-and-carry policy for arms sales, provided the arms were moved from the United States by the buyer's own ships. Immediately, the British and the French established buying missions and offices in the United States to manage their purchases. Unfortunately, the war was expensive, and both countries soon were running out of funds for weapons purchases. But, the United States, restricted by law, could not offer financial aid and could only sell weaponry on that cash-and-carry basis.

The evacuation of British and French troops from Dunkirk in 1940 was a magnificent affair. It is a major example of the contingencies of combat and the types of logistics efforts required but not planned. The Allied forces had been forced

into the Dunkirk area by the German forces and were trapped there by the last days of May. It was at this point the British decided to attempt an evacuation of the more than half a million troops besieged in this stretch of Northwest France.

The evacuation effort was named *Operation Dynamo*. The British had limited naval ships available for this effort, so the government asked owners and operators of any kind of watercraft to volunteer their services for the evacuation. The response was superb. More than 900 craft, with several thousand professional and amateur mariners, came to the fore to create a modern day armada. The armada was formed by craft of every conceivable form, from every British port. There were paddle wheel boats, ferry boats, fire boats, barges, sail boats, row boats, canoes, yachts, fishing trawlers, and tugs. Escorted by Royal Navy ships, they crossed the English Channel. The Channel offered its usual choppy sea and was also mined by both the British and German. Nevertheless, they crossed and approached the beaches of Dunkirk on 27 May.

By 30 May, more than 125,000 evacuees had been landed in Britain. They were almost totally British Expeditionary Forces since the French had not yet received orders to evacuate. As conditions ashore worsened and the Germans tightened their lines against the Allies, the French order to leave was given, and on 31 May, they too began to evacuate. Attacks by the Luftwaffe made the evacuation extremely hazardous, so most of it was done in darkness during the first 2 days of June. The evacuation continued, and by early morning of 4 June, all Allied resistance in the Dunkirk area had ceased. The German troops took over the area and captured what has been estimated at more than 40,000 troops still on shore. Overall, the evacuation moved about 340,000 troops to Britain. Approximately 100,000 were lost to the sinking of ships, drowning while trying to swim in heavy uniforms, bombings, artillery fire, and the like. The 340,00 rescued troops, however, provided the core for the future combat efforts of the Allies until the United States entered the war following Pearl Harbor.

The spring and early summer of 1940 shook much of the smugness from the Congress and the people. In May, the Allies evacuated their troops from the European Continent with the action at Dunkirk. Most of the military personnel were rescued in the evacuation, but a great part of the Allied weaponry had to be left on the beaches for lack of adequate shipping to remove it. Germany now had most of Europe in its control. Italy invaded France and entered the war as a German ally on 10 June. On 13 June, Paris was declared an open city in an effort to avoid its destruction. The United States and the rest of the world were shocked deeply by pictures of Nazi swastikas on the Eiffel Tower.

France surrendered to Germany on 21 June. Germany displayed its power and vindictiveness by insisting the surrender take place in the Compeigne Forest, the same location and in the same railway car in which it had signed the surrender documents of World War I.

Germany's *blitzkrieg*, mobile war, had proved it possessed a tremendous capability to wage war on the ground, at sea, and in the air. It was now obvious how well that country had prepared for this war. The Nazi military had amazing quantities of war machines at its disposal, and its military personnel were plainly very well trained. The US Congress and the US people were truly shocked.

Increasing Action for National Defense

New impetus was given the economy when, in May 1940, Roosevelt asked Congress to authorize the production of 50,000 military aircraft per year. Never before had there been a production proposal of this magnitude. To do it, he asked for $900 million to be devoted to the program. A few weeks later, he asked Congress for $1 billion for national defense efforts. In June, he signed into law an appropriations bill for $1.3 billion for Navy construction and 2 days later signed authorization for increased Navy and Army aviation forces.

Meanwhile, Britain and France were pleading for help that would not require them to provide money they no longer had. Britain had commandeered investments and accounts of its citizens in US banks and businesses and used that money to buy weapons under the cash-and-carry requirements. But they were running out of even that capability. Roosevelt, in conjunction with the War Department, began one of his several ruses to undermine the Neutrality Act. He had the War Department declare military materiel (which were, in truth, in short supply in the American military) surplus and available for sale to US companies. These *surplus* stocks of rifles and artillery pieces were sold to US Steel, who in turn resold them to Britain in a manner that bypassed the law. Shipments began immediately.

July 1940 was an active month for military growth. On the first day, Roosevelt signed an authorization bill for 45 new Navy ships and on 19 July signed the Two Ocean Navy Expansion Act authorizing additional ships and as many as 15,000 aircraft. Under these acts, the Navy was now authorized 35 battleships, 20 aircraft carriers, and 88 cruisers in addition to its many smaller ships.

On 23 July, Britain received approval to purchase up to 40 percent of all US aircraft production. The next week, government action prohibited the exporting of oil and certain metal commodities to countries outside the Americas. This action was aimed primarily at Japan, and as Japanese oil supplies declined, she had to look to Southeast Asia to meet her needs. Some people believe this action and similar later ones created the conditions that led to the attack on Pearl Harbor.

Action begun in July was completed in September, and Britain began receiving, on 9 September, 50 World War I vintage destroyers from the Navy. In return, the United States received base rights in the West Indies and Bermuda, which became very important to the United States after entering the war.

It was obvious to most people now that the United States must increase its military strength. The war in Europe and the militaristic acts of Japan indicated that we would be treading on treacherous ground if we persisted in our isolationist thoughts and the faulty protection of the two large oceans.

Congress, in its questioning of military capability in late summer of 1940, was shocked to discover the Army did not have enough antiaircraft weapons to even protect a single major US city. They found that some coast defense guns had no real operational capability. The Army had virtually no tanks, and the field artillery was relying on approximately 5,000 French 75s left from World War I acquisitions (119:411).

Congressional concern and the sense of the people caused the country's first peacetime conscription act to become law as the Burke-Wadsworth Bill on 16 September 1940. Under the law originally, all males 21 to 35 years of age had to register for military service. Registration began on 16 October 1940, and the first draft was conducted on 29 October with Secretary of War Henry Stinson, blindfolded, drawing the first number from a fishbowl. President Roosevelt was in attendance to witness this historic action. Thus began the experience of involuntary service for several million men.

Also, in the fall of 1940, some National Guard units were federalized (called into active service) to increase our military strength and capability. This, like the draft, created some resentment. Many of the guardsmen were family men with jobs. Their call to active service meant dislocation, loss of employment, family separation and, often, exceptional family hardships due to sudden absence of income. The Navy experienced the problem when Secretary of the Navy Frank Knox called up some of the Navy reserve units and personnel in October.

World Tensions Increase

On 26 September, an embargo was placed on the export of all scrap iron and steel to Japan. Later, in many places in the Pacific during World War II, many American servicemen claimed to be able to identify US scrap metal in Japanese bombs and artillery shells. While this was highly questionable, the story was a big one, and it did get some newspaper coverage in the United States.

From 29 January through 27 March 1941, a series of secret meetings between the British and the US military in Washington produced American British Conversations, 1. This was an agreement that in the event of war with Germany and Japan priority would go to defeating Germany first. This policy generally established the strategy of the United States following Pearl Harbor and dictated the logistics priorities for much of the war.

In March, too, the US military visited Britain to select sites for air, ground, and naval forces in the event the United States went to war against Germany. The agreement was for these bases to be equipped and facility construction begun later in 1941. The agreement was effective, and the preparation did, in fact, begin. There seemed little official doubt at this point that war, at least war against the Axis Powers, was probable at an early date although Congress seemed to have no intent to act to declare war. In fact, there is some question whether Congress was advised of this activity.

On 1 February 1941, the Navy reorganized itself into three fleets: the Atlantic, Pacific, and Asiatic. The Atlantic Fleet replaced the Neutrality Patrol that had been ordered by the President in September 1939. He soon ordered ships from the Pacific to the Atlantic to join the Neutrality Patrol whose objective was to detect and expose every German ship in the neutrality zone, which extended through the whole Western Atlantic for about 1,000 miles off the US shores, including Greenland and Iceland (36).

The President, speaking on 15 March, promised the United States would supply Britain and the Allies with aid *until victory*. He further stated, "There is now an end to compromise with tyranny." Later that month, he ordered German, Italian, and Danish shipping taken into protective custody—a nice way of stating they were confiscated. Then, in April, he transferred ten Coast Guard cutters to the British and authorized British ships to be repaired in US yards and refueled in US ports when on combat sailings. Then he declared the Red Sea no longer a combat zone, thereby releasing that area from the Neutrality Law constraints. This gave at least tacit approval to US shipping to sail on cargo runs to Red Sea ports, including the delivery of military supplies for British forces in Egypt and North Africa.

Conditions in the United States were becoming fast paced, and the economy was showing robust signs. Worries began to surface about inflation possibilities and about the need for resource controls and priorities. The Office of Price Administration was created on 11 April to control prices and profits to restrict inflationary growth. A further purpose of the OPA was to balance civilian and military requirements to try to avoid the squabbles and disagreements that were beginning to evidence the urgency of the times. This was the forerunner of a number of wartime control agencies established to control resources, manpower, finances, and efforts.

In mid-April, representatives of Iceland met in New York City with US representatives. They agreed Iceland would not act to resist if US forces were to occupy Iceland in lieu of the current British protective forces. In keeping with this agreement and to release Britain from the protection burden, US Marine Corps forces landed in Iceland on 7 July 1941 to provide protection for US shipping. The Marines were supported by naval logistics forces and from 2 battleships, 2 cruisers, and 12 destroyers.

While the Neutrality Patrol had been reporting on observed German shipping, it had been done in a sort of unofficial manner. In late April, Roosevelt ordered the Navy to have all US warships report on the presence and movement of German naval units in the seas west of Iceland. In some unofficial way, this information seemed always to find its way into British hands for Royal Navy activity. For the most part, German naval units had avoided striking against US vessels, but on 20 May, the *Robin Moor*, a ship of the US merchant marine, was sunk in the Atlantic by a German U-boat (submarine). The President called this action *intimidation* and promised, "We will not yield." That June, probably in recognition of the dangerous trend of war action, Congress received the War Department budget for fiscal year 1942 for $10.5 billion—quite a massive change from those budgets of just 5 years before. The Congress passed it just 23 days after introduction.

In mid-June, the President froze all Axis (Germany and Italy) assets in the United States and ordered all Axis consulates and offices in the United States closed. The closure included all German government and business offices as well. In a matter of days, as expected, both Germany and Italy responded with like actions against US activities in their countries. Then, on 22 June, in a surprise move, Germany invaded Russia counter to agreements reached earlier with that country. Roosevelt immediately announced that the United States would support Russia with aid, and the Soviet Union was included in lend-lease activities.

Recognizing the growing threat to the United States and the need to speed up military preparation, on 10 and 11 July, Roosevelt asked Congress for additional funds for the military. He requested and later received $4.7 billion for the War Department and $3.3 billion for the Navy Department and the Maritime Commission. On 11 July 1941, he also created a new civilian intelligence activity headed by William Donovan. Later this activity became the Office for Strategic Services (OSS), which later became the Central Intelligence Agency (CIA). The CIA functions to current date.

On 21 July, the President asked Congress to extend the draft period for conscripts from 12 months to a new service length of 30 months. He further requested a similarly increased service length for federalized National Guard forces. There was much opposition to this move, and Congress debated it heatedly, but it passed the Senate on 7 August and the House on 12 August. However, the passage was by a slim majority. It passed by one vote. This was reflection that, despite everything that had happened in the last several years, support was not all that great for a strong and growing military force and for more active military support programs.

The Japanese, meanwhile, continued to act belligerently through the Pacific Basin and in Asia. Their actions caused the President, on 26 July, to freeze all Japanese assets in the United States. Japan retaliated on 28 July. The US action stopped almost three-quarters of Japan's foreign trade, and when the Dutch froze Japanese assets in the Dutch East Indies, the Japanese oil supplies were effectively cut off creating a major long-range problem for the country and its military machinery. In early August, the United States forbade the export of oil and aviation fuel from the United States except to Britain, the British Empire, and the Western Hemisphere countries. This further aggravated the Japanese oil supply situation. The was presumed to be a strong message to Japan that it had better change its foreign policies or decide to go to war to try to obtain oil supplies from Southeast Asia. Many people now claim this action was the trigger that pushed the Japanese into attacking the United States 4 months later.

The Philippines were still under US control at this time. Douglas MacArthur had retired from the US Army to head the Philippine Army. On 26 July, Roosevelt ordered the Philippine military forces incorporated into US military forces so long as the tension regarding Japan continued. MacArthur was called back to active US Army duty to command the combined US-Philippine forces. This added significantly to the logistics problems of our overseas military growth. Of course, as it turned out, the move was too close to the Japanese attacks in December to allow for much logistics growth in the Philippines.

The growing collaboration of the United States and British governments was effective in arranging many agreements while at the same time upsetting many Americans who still harbored isolationist views. Yet, in Newfoundland, 9–12 August, Roosevelt and Winston Churchill secretly met to discuss world conditions. Particular attention was given the war in Europe. A tacit agreement was reached, which in effect stated that the United States would enter the war on the side of the British if Japan attacked either British or Dutch holdings in Malaysia or the East Indies. Obviously, the President had no real authority to agree to such action without Congress acting to declare war. Nevertheless, he did, and he sent a strong message to Japan on 17 August, effectively stating US opposition to Japanese actions.

This secret meeting developed the Atlantic Charter. The charter stated the principles of the United States and Britain, which declared that all countries, anywhere in the world, should be free of any form of foreign pressure and should have the unequivocal right to hold free elections. In late September, 15 countries (including the United States, Great Britain, the Soviet Union, and others) signed the Atlantic Charter in London.

Also, in September, the Navy began patrols in the Denmark Strait, and the President authorized the Navy to escort merchant ship convoys in the Atlantic. This was authorized whenever there was at least one American ship in the convoy. On 4 September, the *USS Greer*, a destroyer on convoy duty, was attacked by a German U-boat but was not damaged. The *Greer* depth-charged the submarine, but no positive evidence of success was collected. In September, Roosevelt ordered Navy ships to *shoot on sight* in any part of any ocean when considered necessary for US defense. There was little question, at this point, that the United States was getting close to war. Its actions were getting closer and closer to active involvement even though no congressional action had been taken to establish a state of war.

October and November 1941 saw increasing US Navy activity in the Atlantic, in particular, and more frequent confrontations with Axis naval units. In early October, Roosevelt asked Congress to authorize him to arm US merchant ships. At the same time, he asked to have the Neutrality Act softened. About 5 weeks later, after considerable debate, Congress passed the authorization he sought. The passage votes were very close, again indicating a lack of general US resolve even though US ships had been sunk and US lives lost. Congressional action allowed US merchant ships to be armed and further permitted them to enter declared war zones. In mid-October, the *USS Kearney*, a destroyer, was torpedoed by a U-boat in the Atlantic, and 11 sailors were killed. Two weeks later, the *USS Reuben Jones*, another destroyer, was sunk by U-boat action, and 100 sailors lost their lives. On 2 November, the President removed the Coast Guard from under the Treasury Department and placed it under the Navy, in effect indicating a state of war even though undeclared. On 25 November, the Navy established mandatory convoying of merchant shipping in the Pacific in view of the tense conditions there.

During 1941, the Allies lost about 1,200 ships representing more than 4.5 million tons of capacity. Even so, the British received approximately 60 percent of their normal peacetime dry cargo transport. Though this was a relatively good situation, considering the circumstances, the British had begun strict rationing of all nonmilitary goods and resources. As the year came to an end and the United States entered the war following the Japanese attacks on Pearl Harbor and the Philippines, the rationing became even stricter and was followed by similar action in the United States.

In early December 1941, though, the United States was still functioning as a nation at peace. There were still more than 5 million people unemployed, although the military buildup and the supply of the Allies were rapidly creating jobs and income. Prices were in check, and a man's suit could be purchased for $15, a new Chevrolet sedan for $900. The acceptance of the people for the military buildup was reflected in growing numbers of advertisements in magazines and newspapers containing notations or references to things military (129:3-6).

Civilian Defense

In those days, there really was no established civilian defense program. The conditions and moods of the 1920s and 1930s certainly had not directed American actions or plans for such activity. Yet in May, the President established the Office of Civilian Defense (OCD) headed by Fiorello LaGuardia, the Mayor of New York, with Eleanor Roosevelt as his assistant. The two had disagreements about the priorities to be followed, but the program did get underway (129:26-47).

Scrap drives were held, but they seemed ineffective even though the people were enthusiastic. People were urged to contribute their pots and pans so the aluminum could be recycled for aircraft construction, yet the piles of pots and pans sometimes stayed in the collection points for months without being picked up for salvage. The same seemed to happen with clothing drives, tool drives, and so forth. Obviously, the plans were incomplete at the time, and the program was never really brought to fruition as visualized.

There were conflicts between OCD in Washington and local Civil Defense organizations. There were not enough sirens to be issued for all communities, and production seemed not to have the needed priority. Everyone complained that there was an absence of leadership policy and direction covering such basics as the use of lights at night and so forth. The local Civilian Defense units often became quasi-military, and some people likened them to the posse of the Old West. Many people complained about poor leadership locally and nationally, with particular complaints coming following Pearl Harbor and the natural nervousness of that time.

Just before Pearl Harbor, the OCD took control of all light aircraft as the Civil Air Patrol (CAP). The War Department was not enthusiastic about this and, at first, was not very supportive. Later, of course, it became very supportive, and today the Air Force closely supports the CAP. But in 1941, CAP was new and not qualified for long over-water patrol flying or submarine patrol. It lacked essential equipment, and the pilots often lacked training. However, they soon received the necessary equipment and training and began to perform in an outstanding manner—as they did throughout the war and have since.

The point is the OCD was another logistics problem for the country and the military. It was smaller than the war, of course, but large enough to be troublesome at times. They needed essential equipment such as gas masks, helmets, stirrup pumps, gas alarms, sirens, uniforms, paper, printing, fuel, communications, flashlights, maps, and so forth—all items that the US and Allied military forces needed with equal or greater urgency. The disputes over supply priorities caused the civilian defense effort to be a significant logistics problem for the country early in the war when such infighting was dysfunctional. It generally resolved itself over time, but the United States never had a truly effective civilian defense program.

Lend-Lease

The Lend-Lease Act of 1941 was action on Roosevelt's expressed wishes in a Fireside Chat of 29 December 1940 for the United States to aid Britain and to become the *arsenal of democracy*. The act provided great support to the Allied countries in World War II. That war truly stretched worldwide. In some manner, every country of the world was involved either in military, economic, or political activity related to the war.

In 1940, the war in Europe was not going well for the Allies. Germany was using its blitzkrieg tactics with devastating results. The Allies were forced into a small area of France and, from 26 May to 4 June 1940, evacuated their troops from Dunkirk, essentially giving up the Continent to the Axis Powers. Approximately 380,000 Allied troops were encircled by the Germans and trapped in a 60-square-mile area of France. Getting them out was a major concern because they would be captured or destroyed, and further military action against Germany would be extremely difficult. The people of Britain responded with more than 800 boats of all kinds and began the miraculous evacuation. Most of the personnel were removed, but great masses of military equipment had to be left on the beaches. It was estimated the forces lost more than 75,000 vehicles, 6,400 antitank weapons, 11,000 machineguns, and 1,200 artillery pieces. Further, the British lost 180 aircraft supporting the evacuation (94). Thus, it was a glorious saving of human resources but an almost fatal loss of military capability.

The British still had to live and fight. They required 1 million tons of materiel a day just to survive let alone conduct a war (89). In December 1940, Roosevelt announced in a news conference his aim to remove the dollar sign by *loaning* war materiel to the Allies. His intention, of course, was to aid the British, not merely to pass the cost of the war to the United States.

Isolationism was still strong in the United States, and there was much argument about this announced intent. There was, however, considerable support for the idea of aiding Britain, and in January 1941, a bill was introduced in the Congress authorizing lend-lease activity by the government. Final

passage of the Lend-Lease Act came on 8 March 1941. The law stated the President might "sell, transfer title to, exchange, lease, lend or otherwise dispose of any defense article to any country whose defense the President deemed vital to the defense of the United States" (119). The act began with authorization to transfer $1.3 billion from materiel on hand or being produced.

The first lend-lease appropriation came on 25 March 1941 for $7 billion with $4 billion coming from Army-type materiel and $3 billion from the Navy. In October, a second appropriation for $5.985 billion was authorized with $2.4 billion being Army and $3.5 billion being Navy. The materiel included such items as various forms of ordnance and supplies, aircraft and aeronautical supplies, tanks and vehicles, and miscellaneous military supplies from the Army; ships and naval supplies from the Navy; and a host of vital civilian support supplies including foodstuffs, business supplies, and so forth.

By this time, Germany had invaded Russia, and Russia needed support. So a conflict began to emerge among the Allies because the British were concerned that Russian needs would cut into the availability of supplies for them. Further, the US military began to actively complain about the impact of lend-lease and the earlier actions on the ability to supply, equip, and train our growing military forces. To help solve the problem, Roosevelt obtained agreement from US military leaders that US forces would obtain only one-half the equipment authorized them—the balance being divided among Britain, Russia, and the Free French. Initially, the Lend-Lease Act was designated to expire on 30 June 1943 so far as initial commitments to contracts were concerned. However, deliveries could be continued to contract completion or to 1 July 1946, whichever was first. Naturally, our entry into the war following Pearl Harbor changed this, and extensions were authorized. The final date authorized for contract commitment was 30 June 1946 with delivery through 1 July 1949.

In the meantime, however, the war had to be fought, and lend-lease became a major source of supply for many countries. Ultimately, the program provided materiel, civilian and military, support, to all the countries of the British Empire, Free France, Russia, China, and Latin America.

On 9 May 1945, President Harry S. Truman declared V-E Day: the war in Europe was ended with Germany's surrender. The concentration of effort swung to the Pacific and the war against Japan. On 5 July, Truman sent a memo to the Joint Chiefs of Staff stating that, with the end of the war in Europe, further lend-lease would be approved only if it were going to be used against the Japanese. No shipments or authorizations for other purposes were authorized. The war against Japan came to a successful close when Truman declared V-J Day on 15 August 1945. That day he also stopped all further lend-lease shipments, effective 24 August 1945. The program had been effective for almost 4-1/2 years and had cost the United States approximately $48 billion in 1940's dollars—a sum approaching $300 billion or more in today's dollars. Table 1 shows the magnitude of the US contribution to Allied war efforts.

Program Dates: 11 March 1941 to 24 August 1945

Program Cost: $Billions (1940's Dollars)

Countries Served:	
British Empire Countries	$31.6
USSR (Russia)	11.0
Free France	3.3
China	1.6
Others	.5
Supplies Procured and Delivered	
Aircraft/Parts	8.2
Combat Vehicles/Parts	3.9
Trucks/Parts	2.5
Weapons/Parts	3.0
Ammunition Supplies	1.5
Clothing, Chemical, Ships,) Machine Tools, Food,) Medical, And so on.)	28.9

Note: Much of this last group was for civilian support: 75 to 80 percent of lend-lease shipments were civilian support supplies.

Source: 22^d Report to the Congress on Lend-Lease Operations, 14 June 1946

Table 1. The US Lend-Lease Program

From April 1941 to V-J Day, lend-lease was an integral and essential part of US military logistics. Supply operations for US forces and Allied governments were key to our final victory. Further, the lend-lease program was vital for the preservation of life and the general economic survival of our Allies fighting to defeat Germany, Italy, and Japan. It was a massive effort that gained us sorely needed time, built up our industrial base, and continued the protection afforded by our Allies. There is little doubt lend-lease preserved our Allies and their governments and kept relentless pressures on our enemies.

Our efforts to control the seemingly inexhaustible wants and needs of so many nations resulted in a host of controls and controlling agencies. Some were unusually complex, some unnecessarily so, yet all in all, the overall process worked amazingly well. The system of support delivered vitally needed civilian and military materiel to all parts of the world. We delivered overland through Iran to Russia; by sea through the North Atlantic to Murmansk, Russia; by air to Russia; flying the *Hump* from India and Burma into China; overland via the Stillwell Road to China; and by sea and air to the British Empire countries, Free French, and Latin America. It was a truly huge and complex effort.

Yet, it was not all giving on our part. There was a *reverse lend-lease* that was of great help to US forces around the world (119, 140, 141, 148, 159). The Act of 1941 authorized the President to accept payment in kind, property, or any other direct or indirect benefit for lend-lease. This permitted US

theater commanders to arrange for the use of local facilities and for the procurement of local supplies, without cash transactions. Theater commanders used this authority to obtain US troop support in foodstuffs, clothing, buildings, some equipment, labor, and services.

Overall, the *reverse lend-lease* had an estimated value of about $8 billion with the greater part of that coming from British Empire countries. We must bear in mind, this support came from nations already strapped financially because of the war. Very likely, the reverse lend-lease cost the other countries a proportion of their gross national products roughly equal to the lend-lease proportion of our gross national product. So it was not all our giving and the Allies taking. We also took and they also gave, as much as they could.

The Lend-Lease Act of 1941 was the capstone of a series of events taken in coordination with the British primarily, and later the other Allies, to support their actions against the Axis Powers. Later, of course, it aided our fight against the Japanese following the bombing of Pearl Harbor and our loss of the Philippines. But, in review, it was an essential part of the process that enabled us to retain our freedoms and lifestyle.

Without great detail, we can retrospectively see the following benefits of the lend-lease program:

- It gave the Allies vital support and sharpened their resistance to the enemies. It can be fairly stated the survival of many of the Allied nations is a direct result of this support.
- It permitted the early war to be carried in great proportion by the Allies since the United States was, by law, unable (unwilling?) to participate then.
- It gave the United States a group of allies capable of doing their share and, often more, of the actual combat.
- It gave the United States and the Allies a high degree of standardization of weaponry although this was an unintended effect. Thus, it greatly simplified the logistics and supply systems in use then and later in the war.
- It stimulated US industry at a time when its overall capacity was very low and, therefore, aided in our escape from the Great Depression.
- It gave us an early start on expanding our industrial base for wartime and had overcome much of the industrial lead time when we actively entered the war in December 1941.
- It developed and proved the need for an extensive transportation network, which proved of inestimable value once we entered the war. Further, what we learned then was probably of greater benefit in creating and operating the postwar transportation systems than in the war.
- It gave the United States leverage to influence and sway Allied opinions and policies. We could *be heard* when debating policy and frequently were able to persuade another country to go with us even if contrary to its own immediate best interests.
- It developed the *reverse lend-lease,* which was essential to our troop support to foreign lands during the war. We received bases, food, clothing, services, facilities, and equipment. It would have been much more difficult without that support.

Mobilization Continues

Meanwhile, selective service proceeded. Several hundred thousand young American males received letters, which began with "Greetings," informing them their friends and neighbors (acting as local draft boards) had selected them for induction and training. These young men went into the service reluctantly for the most part. The economy was just beginning to show signs of recovery under the impetus of the military orders from the Allies and from the growing US military. Jobs were again becoming available, and after the long Depression, this was most welcome news to all. Yet, here they were being required to give up that opportunity and in its place take a position in the military with an income of $21 per month plus room and board. Many of them found there were no uniforms for them when they arrived at their first station . Many found they could only occasionally train with a real weapon since there were so few available. Many had to sleep in tents while cantonment areas were under construction. Many were being supervised by newly promoted noncommissioned officers who had been mere privates themselves just a few weeks earlier and who were not sufficiently experienced or schooled to offer realistic training or to answer questions about why things were done.

Pearl Harbor

Even though we were making progress in our military buildup, we were not ready for the onslaught of the Japanese at Pearl Harbor, Hawaii, 7 December 1941 and the subsequent attack on the Philippine Islands and other Pacific stations. We were increasing our military strength but were, in truth, still in the building stage. However, despite the mood of the country through the 1930s, the Depression, and the budgetary constraints, our reactions to the war in Europe had produced fortunate actions. We had begun the creation of a military industrial base, we had selective service in operation, production of some war materiel was online, budgets had been increased, and some of the vital lead times were begun. Most important, the Depression had been overcome, and the economy was recovering. These 2 years of preparatory actions, even though somewhat restricted, made us better prepared for war than we had ever been when a war began. But we were not well prepared everywhere. For example, Canton Island, vital for Pacific supply, was protected by one platoon armed with rifles and pistols. Wake Island was defended by twelve 3-inch antiaircraft guns, six 5-inch guns left from World War I, and just twelve fighter aircraft of not very modern design (148:10).

The Japanese attack initiated a tidal wave of patriotism from Americans. Concurrently, they expressed outrage and resentment at the apparent treachery of the Japanese. Most Americans thought the nation had treated the Japanese government well, and they were decidedly upset with this horrible action by that country. Labor units immediately began pledging they would not strike until the Japanese had been defeated. That pledge did not hold through the war, but it was

indicative of the moment. Young men crowded into recruiting stations to enlist to help beat the Japanese. Voluntary enlistments in the Army and Navy were still permitted at this time. They were not stopped until later in the war when full dependence on military manpower was placed on the draft. Business owners and managers quickly asked what they could do, and the common business call was for patriotism before profit (129:14).

Even so, the men in the military services, despite the Japanese attack, were upset with their military experiences. Surveys of enlisted men, scheduled earlier but still conducted on 8 and 9 December, reflected great dissatisfaction with:

- The uniforms (or lack of them).
- Poor leadership by noncommissioned officers.
- *Stupid* training.
- Repetitive training of little perceived value.
- Lack of supply to allow live hand-grenade practice.
- Being unable to fire their rifles often enough to become competent marksmen.
- Lack of tanks with which to train.
- Displeasure with the *military caste system* separating enlisted men and officers.
- Draftees being called *soft* by *ignorant* NCOs and commanding officers.
- Offpost treatment by civilians who seemed to class them as drunks and/or fornicators and generally undesirable (129:15; 221).

At the time of Pearl Harbor, we had 700 cannons guarding the three US coastlines, but more than half of them had been manufactured before 1910. Most of these defensive units had been installed when airpower was not thought of in military terms and they, therefore, had been given no protection from air attack. There were only ten radar installations along the 1,200 miles of the West Coast, and the Fourth Air Force on that coast had only 45 modern aircraft. However, conditions immediately began to change and by mid-January 1942, a month after the attack, more than 250,000 soldiers were in defensive positions on the West Coast.

Pearl Harbor Attack, 7 December 1941. A motor launch rescues a survivor from the water alongside the sunken *USS West Virginia* (B-48). *USS Tennessee* (B 45) is inboard. (Courtesy of National Archives)

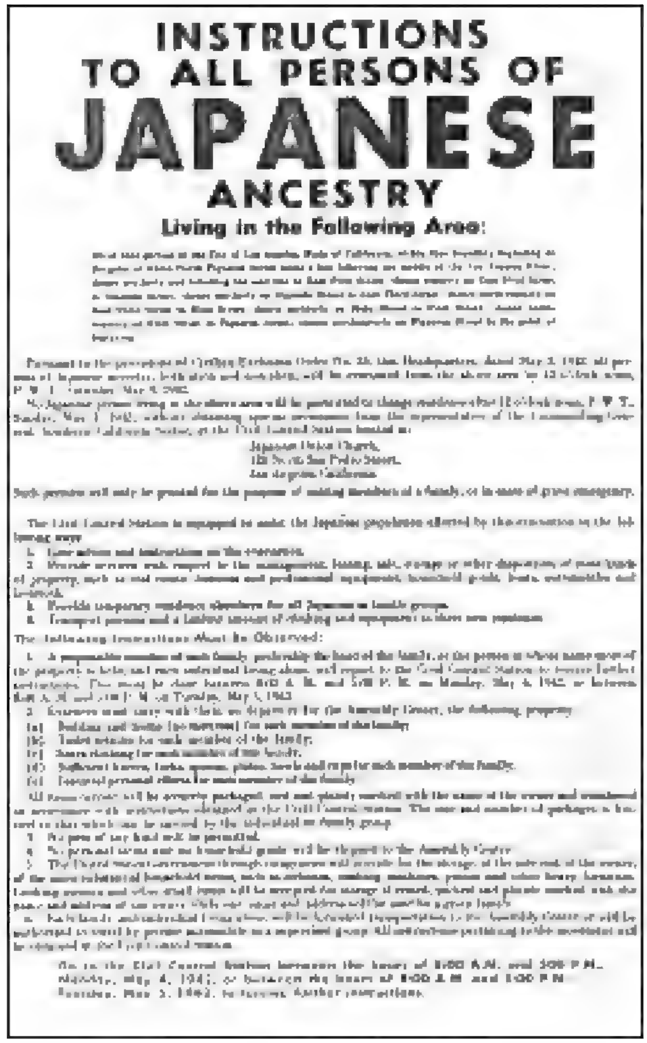
The coming of war brought with it a lot of *panic* activity. No one really knew what the next move of the Japanese might be, and many people on the West Coast felt an attack was imminent. Japanese aircraft were frequently reported observed over West Coast cities and areas. Japanese battleships were reported just 150 miles off the San Francisco coast, but fortunately, these ships turned out to be fishing vessels. Submarine activity was reported on all coasts, and some enemy landings were supposedly involved. Fortunately, none of these proved true, either (129:54). However, on 23 February 1942, a Japanese submarine did surface off Santa Barbara, California. It fired 20 shells at a petroleum complex with no reported damage.

The resentment against the Japanese began to crystallize and focus against all people of oriental extraction. These people were mistreated in many ways at work, on the street, in the shops, and at home. In January 1942, there were calls from a variety of civilian sources (newspapers, Congressmen, civic organizations, and so on) for the federal government to intern all Japanese whether or not they were citizens. Pressure built with many unproven claims that the US-resident Japanese were in radio contact with Japanese ships, sending radio or light signals from West Coast sites, and so forth. At the end of March, by Executive Order 9066, the US Army began the roundup and evacuation of all Japanese. In the following 6 months, more than 100,000 innocent people were uprooted from their homes and businesses and placed in interment camps under armed guard (129:75-6). They unfairly lost their property and businesses, lost face, and for many, lost faith in American

fairness. The conditions of this American failure are still under correction although there really is no way in which the event can be corrected or satisfactorily explained. The interment is mentioned at this point because it added another major logistics problem (transportation, housing, feeding, care, and so forth) to a system already overloaded and struggling.

Summary

The prewar period was one of reluctant preparation for war. The country really did not want to be involved in the European war but had to produce fighting materiel to help its friends who were engaged in that war. As events progressed, it became more evident we had to be prepared for possible US involvement, and we began to enlarge our military and order industrial production items. All of this proved of value when the Japanese attacked us, but we really were not yet ready for war. The shortage of materiel and the lack of adequate training were overcome over time with the impetus of actual war and the surge of patriotism created by the Pearl Harbor attack and the later loss of the Philippine Islands. The early days of the war were days of deep concern because of the lack of weapons and materiel to mount an attack or, in many instances, even to defend strategic sites. Fortunately, the Japanese and the Axis Powers did not take advantage of their strong positions at that time and ultimately lost their advantage and the war.


INSTRUCTIONS
TO ALL PERSONS OF
JAPANESE
ANCESTRY
Living in the Following Area:

The Following Instructions Must Be Observed:

Honolulu Star-Bulletin 1st EXTRA

2 PAGES—HONOLULU, TERRITORY OF HAWAII, U. S. A., SUNDAY, DECEMBER 7, 1941—2 PAGES | PRICE FIVE CENTS

WAR!

(Associated Press by Transpacific Telephone)

SAN FRANCISCO, Dec. 7.—President Roosevelt announced this morning that Japanese planes had attacked Manila and Pearl Harbor.

OAHU BOMBED BY JAPANESE PLANES

SIX KNOWN DEAD, 21 INJURED, AT EMERGENCY HOSPITAL

Attack Made On Island's Defense Areas

By UNITED PRESS

WASHINGTON, Dec. 7.—Text of a White House announcement detailing the attack on the Hawaiian islands is:

"The Japanese attacked Pearl Harbor from the air and all naval and military activities on the island of Oahu, principal American base in the Hawaiian islands."

Oahu was attacked at 7:55 this morning by Japanese planes.

The Rising Sun, emblem of Japan, was seen on plane wing tips.

Wave after wave of bombers streamed through the clouded morning sky from the southwest and flung their missiles on a city resting in peaceful Sabbath calm.

According to an unconfirmed report received at the governor's office, the Japanese force that attacked Oahu reached island waters aboard two small airplane carriers.

It was also reported that at the governor's office either an attempt had been made to bomb the USS Lexington, or that it had been bombed.

CITY IN UPROAR

Within 10 minutes the city was in an uproar. As bombs fell in many parts of the city, and in defense areas the defenders of the islands went into quick action.

Army intelligence officers at Ft. Shafter announced officially shortly after 9 a. m. the fact of the bombardment by an enemy but long previous army and navy had taken immediate measures in defense.

"Oahu is under a sporadic air raid," the announcement said.

"Civilians are ordered to stay off the streets until further notice."

CIVILIANS ORDERED OFF STREETS

The army has ordered that all civilians stay off the streets and highways and not use telephones.

Evidence that the Japanese attack has registered some hits was shown by three billowing pillars of smoke in the Pearl Harbor and Hickam field area.

All navy personnel and civilian defense workers, with the exception of women, have been ordered to duty at Pearl Harbor.

The Pearl Harbor highway was immediately a mass of racing cars.

A trickling stream of injured people began pouring into the city emergency hospital a few minutes after the bombardment started.

Thousands of telephone calls almost swamped the Mutual Telephone Co., which put extra operators on duty.

At The Star-Bulletin office the phone calls deluged the single operator and it was impossible for this newspaper, for sometime, to handle the flood of calls. Here also an emergency operator was called.

HOUR OF ATTACK—7:55 A. M.

An official army report from department headquarters, made public shortly before 11, is that the first attack was at 7:55 a. m.

Witnesses said they saw at least 50 airplanes over Pearl Harbor.

The attack centered in the Pearl Harbor. Army authorities said:

"The rising sun was seen on the wing tips of the airplanes."

Although martial law has not been declared officially, the city of Honolulu was operating under M-Day conditions.

It is reliably reported that enemy objectives under attack were Wheeler field, Hickam field, Kaneohe bay and naval air station and Pearl Harbor.

Some enemy planes were reported shot down.

The body of the pilot was seen in a plane burning at Wahiawa.

Oahu appeared to be taking calmly after the first uproar of queries.

ANTIAIRCRAFT GUNS IN ACTION

First indication of the raid came shortly before 8 this morning when antiaircraft guns around Pearl Harbor began sending up a thunderous barrage.

At the same time a vast cloud of black smoke arose from the naval base and also from Hickam field where flames could be seen.

BOMB NEAR GOVERNOR'S MANSION

Shortly before 9:30 a bomb fell near Washington Place, the residence of the governor. Governor Poindexter and Secretary Charles M. Hite were there.

It was reported that the bomb killed an unidentified Chinese man across the street in front of the Schuman Carriage Co. where windows were broken.

C. E. Daniels, a welder, found a fragment of shell or bomb at South and Queen Sts. which he brought into the City Hall. This fragment weighed about a pound.

At 10:05 a. m. today Governor Poindexter telephoned to The Star-Bulletin announcing he has declared a state of emergency for the entire territory.

He announced that Edward L. Doty, executive secretary of the major disaster council, has been appointed director under the M-Day law's provisions.

Governor Poindexter urged all residents of Honolulu to remain off the street, and the people of the territory to remain calm.

Mr. Doty reported that all major disaster council wardens and medical units were on duty within a half hour of the time the alarm was given.

Workers employed at Pearl Harbor were ordered at 10:10 a. m. not to report at Pearl Harbor.

The mayor's major disaster council was to meet at the city hall at about 10:30 this morning.

At least two Japanese planes were reported at Hawaiian department headquarters to have been shot down.

One of the planes was shot down at Ft. Kamehameha and the other back of the Wa-

(Turn to Page 2, Column 1)

Hundreds See City Bombed

[illegible]

(Turn to Page 2, Column 6)

Schools Closed

[illegible]

Names of Dead and Injured

[illegible]

Editorial

HAWAII MEETS THE CRISIS

[illegible]

BULLETIN

Additional Star-Bulletin extras today will cover the latest developments in this war menace.

Chapter Two

World War II

War came to the United States on 7 December 1941 when Japanese naval forces launched their aircraft against Hawaii. The primary targets were the Navy vessels at anchor in Pearl Harbor, and they were hit hard. Later that same Sunday, the world learned the Japanese forces were also attacking the Philippine Islands and other US sites in the Pacific area. The American people were aroused, probably as never before, with the treachery of Japan, which, at the moment of attack, had emissaries in Washington supposedly working for peace.

While we were really not ready for war, we were probably better prepared than ever before for the conflict. The reason for our emerging military strength was the war in Europe, which had been underway for more than 2 years. In our efforts, first, to help Britain and France in their fight against Axis Powers and, second, to improve our own military capability, we had begun many actions. As we emerged from the Depression, our productive capability and capacity were growing through employment generated by the Allied and our own orders for military materiel.

World War II is full of interesting and educational events. It was the first true *world* war and was fought in almost every major area of the world, ranging from the civilizations of Europe through the deserts of the Middle East to the freezing Arctic to the hot and humid jungles of the Pacific to the China-Burma-India area. The massive movement of forces through and to all these theaters of operation created mind-boggling problems for logisticians. So, too, did the acquisition of supplies and equipment for US and Allied forces spread all around the globe.

The gigantic logistics achievements in overseas theaters during World War II owed less to foresight or planning than to the ingenuity and selfless devotion of thousands of officers and men in the service organizations (148:159). It was the junior officers and NCOs who did what had to be done, often under extreme hardship and terrible odds, and succeeded. It was not high-level planning, although that played a large role in initiating activity that made for victory. It was the troops on the line in the Army, Army Air Forces, Navy, Coast Guard, and Marine Corps who made logistics work effectively around the world.

Even though this history occurred more than 50 years ago, under conditions not likely to be exactly duplicated, we should not refuse to note the intrinsic similarities when they exist today. We should gain insight from the review of history and apply our new knowledge to the current and forecasted world of military logistics.

The Magnitude of the War

It is necessary that we understand a little about the magnitude of World War II. We have mentioned the fact combat took place in almost all areas of the world at one time or another. We have also mentioned that most of the principal countries of the world were somehow involved. But those words may not drive home the real size of this major historic activity, so your attention is invited to Table 2 and Table 3. These two tables, without amplification of words, should impress you with the magnitude of the war. It might be more impressive to multiply the dollar costs in Table 3 by 6 or 8 to get a feel for the cost in today's dollars.

Governmental Controls

As the war in Europe moved into 1940, the Depression began to die, and the American economy showed new life. Britain and France placed orders with US industries for war equipment. The US political body began to note the need for improved US military capability, and President Roosevelt and Congress acted on huge military equipment programs as we discussed in Chapter One.

Our industrial base was not truly ready for the massive orders being received. Further, US military orders, on top of those from the Allies, flooded our industrial units. It was soon obvious we were going to require a high degree of coordination to use our factories with efficiency and effectiveness.

The overload and lack of coordination caused problems with standardization of parts and products. For example, in June 1940, Douglas Aircraft Company was manufacturing seven variations of one aircraft for seven different customers, each wanting specific and frequent modifications and changes to the production model (111:161-5). This created horrendous problems for inventory control and made production extremely difficult and much slower than necessary. Production jigs had to be tailored to the customer's requirements. Efficient workflow could not be planned. Different technical manuals were required for each of the various versions. The constant changes created major problems using relatively untrained workers. Costs were increased and deliveries were missed. What we required was some form of standardization of components and the end products for a specified production run and some form of schedule control so everyone was not after the same scarce resource at the same time. Recognizing this need, a joint Army, Navy, and British committee agreed on forms of standardization and schedule, and the basic problem began to be solved.

Totals for Entire War Period

Country	Total Military	Military Killed	Civilian Killed
Australia	680,000	29,385	—
Austria	800,000	380,000	145,000
Belgium	800,000	9,561	75,000
Brazil	200,000	943	—
Britain	4,683,000	271,311	144,079
Bulgaria	450,000	18,500	??
Canada	780,000	39,319	—
China	5,000,000	1,324,516	10,000,000 est
Czechoslovakia	180,000	6,683	310,000
Denmark	15,000	4,339	??
Estonia	—	—	140,000
Finland	250,000	79,047	??
France	5,000,000	205,707	173,260
Germany	10,000,000	3,300,000	2,450,000
Greece	150,000	16,357	155,300
Hungary	350,000	147,000	280,000
India	2,393,891	36,092	??
Italy	4,500,000	262,420	3,000,000 est
Japan	10,000,000	1,140,429	3,000,000 est
Latvia	—	—	120,000
Lithuania	—	—	170,000
Netherlands	500,000	13,700	236,000
New Zealand	157,000	12,162	—
Norway	25,000	4,780	5,417
Poland	1,000,000	320,000	6,028,000
Rumania	600,000	519,882	465,000
S. Africa	140,000	8,681	—
Russia	20,000,000	13,600,000	7,720,000
USA	16,353,659	262,131	—
Yugoslavia	3,741,000	305,000	1,355,000

Note: The military figures in column one reflect total inducted/enlisted during the full war. These figures do **not** reflect the peak strength, which was always lower—sometimes decidedly lower.

Source: Robert Goralski, *World War II Almanac: 1931-1945*; New York; Bonanza Books, 1981 (425-428).

Table 2. Manpower Costs World War II by Country

Agreements meant increased needs for communication, coordination, and control. A base for this had been created in 1922. The Army-Navy Munitions Board generally planned well for strategic and critical materiel, industrial capacity, and production priorities. The Munitions Board had also issued a statement of national mobilization requirements, which, unfortunately, was largely ignored. The Board's planning included assertions a large war would require management of the national economy, a concept not readily accepted then by many of our people. The Board's Industrial Mobilization Plan was issued in 1931 and revised in 1933, 1936, and 1939. It was the only base from which to progress as the war in Europe heated up.

In late 1939, as the war in Europe began, Roosevelt directed the Army-Navy Munitions Board to report directly to him. His intent was to lessen bickering and parochialism, which tended to delay actions and cause dangerously resisted coordination. In 1940, sensing a need for even better planning and coordination, Roosevelt revived the Council of National Defense, which had been created in 1916 but which had fallen inactive. This Council shortly became the National Defense Advisory Commission manned by seven prominent leaders of business and industry. In January 1941, the Office of Production Management came into existence followed in 2 months by the Office of Lend-Lease Administration. One month later, the Office of Price Administration was created and, in August, the Supply Priorities and Allocation Board. After Pearl Harbor, in January 1942, the War Production Board—headed by its *czar*, Donald Nelson—replaced the Supply Priorities and Allocation Board (168).

As can be seen, there was a lot of confused and confusing effort to manage the economy for war production needs. We

Country	Cost
USA	$288,000,000,000
Germany	212,336,000,000
France	111,272,000,000
Russia	93,012,000,000
UK	49,786,000,000
China	49,072,000,000
Japan	41,272,000,000
Italy	21,072,000,000
Canada	20,104,000,000
Australia	10,036,000,000
Netherlands	9,624,000,000
Belgium	6,324,000,000
India	4,804,000,000
New Zealand	2,560,000,000
Sweden	1,752,000,000 (Neutral)
South Africa	2,152,000,000
Turkey	1,924,000,000
Switzerland	2,334,000,000 (Neutral)
Norway	992,000,000
Portugal	320,000,000

Some other countries have not, over the years, publicized costs for their part in World War II (Brazil and other American countries, for example).

Note 1: These costs are approximations. No accounting systems existed to definitely assign costs in any of the countries. Many costs have never been assigned in all likelihood. But these data should indicate the enormous financial burden of the war. *Note 2*: All figures reflect costs in US dollars of the 1940-1945 timeframe.

Source: Robert Goralski, *World War II Almanac: 1931-1945*; New York; Bonanza Books, 1981, 421.

Table 3. World War II Dollar Costs

really had not made planning for such action even though it should have been obvious there would be massive needs for such control and coordination. We had to have some form of control and decisions about priorities, the use of materiel, the use of production capacity, and so forth.

These stabs at control did manage to work despite almost constant conflict throughout the war among the Services and between the United States and its Allies. For reasons not fully clear, even at this stage, the various boards and control functions were not given specific authorities and guidance. Instead, they were forced to work with often divided leadership and much too vague guidance, direction, and authority.

The Joint Committee of 1939 became stronger and more effective with the initiation of the Office of Production Management. For example, in early 1940 the Joint Committee consisted of General Arnold, Army Air Forces Commanding General; Admiral Towers, Head, Navy Bureau of Aeronautics; Sir Henry Self, Head, British Supply Council; Merrill Meigs, Head, Aircraft Section, Office of Production Management; and four others of equal status and authority. With this kind of membership and a growing understanding of each other's needs, the Joint Committee was able to more effectively function to control aircraft production—a most vital war requirement for the conditions that later developed.

It was soon evident the growing US defense efforts and the rapidly increasing needs of the British could not be met without further controls. As we progressed through the early 1940s preceding Pearl Harbor, there was growing recognition these controls would exceed anything ever before experienced by the American people. The growth of controls proceeded very rapidly, and soon the federal agencies told the people:

- What they could and could not produce.
- The price they could charge for specific items.
- The profit they might make.
- The people they might hire.
- The products they might buy.
- The wages they could pay.
- The prices they would pay at retail level.
- What they might pay in rent and so forth (1:132).

When the United States started in late 1940 to draft people for involuntary military service and then began to help or coerce other people to find essential war jobs and limit their hourly wages, the national government became very strong. Through the war period, the Washington agencies ultimately controlled almost everything the people had personally controlled previously. In addition to all the controls listed above, federal controls came into being for the use and sale of commercial products through a complex and encompassing rationing system.

Further, federal agencies took over many states' rights, often without complaint in recognition of the emergency need but just as often with some bitter complaints by individual states. Generally speaking, rationing and conscription were accepted federal actions. Not so, though, with wages, prices, profits, rents, and so forth (1:132).

	Sep 1939	**Jan 1942**	**Jul 1943**	**Jul 1945**
War Dept	123,000	530,000	1,404,000	1,138,000
Navy Dept	92,000	328,000	674,000	698,000
Emerg War Agencies	-----	30,000	183,000	160,000
Others	725,000	815,000	865,000	280,000
Total	**940,000**	**1,703,000**	**3,126,000**	**2,900,000**

Table 4. Federal Civil Service Growth

The growth in federal control and coordination agencies naturally led to a growth in the number of federal civil service employees. Table 4 reflects that growth, but we must note the majority of the increases existed in the two military departments. Further, we must also note that, while the emergency war agencies grew to a little more than 180,000 people, those agencies did not exist prior to the war. These were agencies established to control specific functions or industries (such as rubber or oil), agencies with authority over economic areas (such as production or manpower), and agencies responsible for coordinating the overall mobilization process (1:132-133).

All these efforts seem to have helped. The job was done effectively and with minimal constraints on freedoms. We should not now judge too harshly as we reflect upon the seeming confusion, misdirection, and growing bureaucratic structure. It did get the job done effectively and successfully. In fact, during the war, the cost of living for the civilian populace increased by only 10 points over that of 1939, while at the same time, we armed and supplied the free world military machines.

Logistics Planning

We needed logistics planning long before we became involved in World War II. However, for the most part, the military forces of the United States seemed not to recognize it as a legitimate military requirement until almost midway through the war. The First World War had been a single theater, essentially single front war, as had been those wars preceding it. Those who planned our national defense expected US industry to have almost unlimited capacity for this kind of war and a relatively simple military operation. The need for a proper organizational placement for logistics planners and their proper involvement in military strategic and tactical planning was not generally recognized. In fact, operational planners and the strategists thought they could do their best work if not hampered by the constricting thoughts of the more practical logisticians (148). Until World War II, it was thought enough to have just the imagination and ideas of the tactical and strategic people included in military considerations and planning. Logistics, if thought of at all, was merely expected to do whatever it was these other *real military planners* expected them to do (15).

Troop carrier, *USS Clay* (APA-39), 10 July 1945, off San Francisco, California. (Courtesy of James C. Fahey collection, Naval Institute Photo Collection)

The omission of logisticians from service and joint planning was later brought out by Major General Orval R. Cook, deputy director, Services, Supply, and Procurement, in a speech to the Air War College, Maxwell Field, Alabama, 10 December 1947. He was explaining some of the major logistics problems of World War II and said, in part:

> Logisticians had to outguess strategists in order to have the time needed for producing the munitions required for a strategic plan. Thus, logistics was compelled to anticipate the plans and decisions of the JCS, Combined Chiefs of Staff, and the War Department General Staff

So, the logistics planners and those working to develop requirements figures had to work by guess and intuition. Obviously, they had a high error rate, and there was much waste of scarce material resources, manpower, time, and money. No doubt there were lives lost because of this inadequate planning forced on logistics by miserable communications and the absence of coordination.

From the start of our war preparations, it became evident logistics was going to be the deciding factor of strategy and tactics. That is, it became evident to all but the strategic and tactical planners. Logistics, being everything needed to create and sustain military force for the United States and its Allies, was the limiting factor. In reality, during the war and its preparatory times, logistics often dictated strategic decisions. Obviously, if logistics could not support it, the best laid strategic or tactical plan might be of little value because we might or might not be able to marshal the required people and other resources.

Soon after we became actively engaged in war, it became clear we would not be able to logistically meet all the requirements for troops, shipping, aircraft, food, and everything else for all fronts and all forces simultaneously. Our available naval forces would have to be, for the most part, employed in the Pacific to protect Australia and to stop the Japanese. That might be the initial immediate priority, but as soon as the Japanese were halted and Australia was safe, we would have to concentrate our resources to create the bases and the forces to destruct the Axis Powers. After that was done, we could concentrate on large-scale attacks on Japanese holdings and defeat that nation. So most supplies and equipment, along with personnel commitments, went to the European theater of operations following shipments to the Pacific for the protective and holding forces. The speed with which the first days of the war progressed caused a great deal of unilateral actions by the individual Services and planners (148).

But we learned World War II could not and would not be fought this way. We learned that requirements determinations could not be effectively made without operational planning (strategic and tactical) being made known to logisticians. And logistics had to be involved early and continuously if we were to succeed. Further, we learned that military materiel had become far too complex and sophisticated to be treated without coordinated planning. There were long lead times to consider and production difficulties to overcome. Distances were great in World War II, and transportation had to be a major consideration. Even the diehards soon learned that logistics could neither create nor support the desired military capability around the world unless it was included in cooperative and coordinated planning involving all the Services as well as our Allies. That was never fully done though, and there was a lot of parochialism and Service myopia that led to inefficiencies and, sometimes, ineffectiveness (15, 148, 225).

There was interservice rivalry and intraservice rivalry. In the Army, for example, there was conflict between the United States Army Air Forces (USAAF), Army Ground Forces, and Army Service Forces. No common logistics organization or procedure existed. Air Force publications did not apply to the other forces or theirs to the Air Forces. Within the Services, there was conflict between those in the United States and those overseas. Theater commanders were extremely jealous of their command prerogatives and did not happily accept direction from the United States. Those Air Force publications earlier mentioned, for example, applied only to US-based units; overseas Air Forces were not bound to follow them.

There was no logistics doctrine for the individual Services or the whole of the military. Each theater of operations had its own unique logistics organization. Training and preparation of logistics personnel were extremely difficult. The trainees could not be told who did what for whom or when without knowing to which theater each person was likely to be assigned. Further, procedures were theater peculiar, which made effective stock control, for example, a practical impossibility. As troops advanced through combat gains in North Africa or the Pacific, for example, much of the unit's supplies and equipment was left behind at rear bases (148:164,

170), and there was much waste because there were no provisions for rollup of the abandoned or nearly abandoned bases.

Within the theaters, there was often conflict between the Services as, for example, in the Pacific between the Army and the Navy. MacArthur and Nimitz each separately controlled an area of the Pacific, and each received his orders from his Service chief in Washington. Overall direction of operations in the Pacific was in the hands of a committee, and below that, there was no single agent of authority to decide on problems and opportunities in the Pacific theater (225:144). Additionally, there were frequent personal problems between the leading figures of the military services of all the Allies, including the United States. The Service jealousies led to constrained thinking on the part of many military leaders and, in turn, led to inefficiencies and waste as well as inability at times to most effectively react to combat conditions. Coordinated and cooperative planning was needed but for the most part did not exist (148).

In the Pacific, there was little joint logistics because of peacetime conflicts of philosophy as with the Army Air Corps and the battleship Navy. As we moved to defend the Pacific and later to assume the assault against Japanese forces, each Service obtained its own shipping, airlift, supplies, construction, and priorities leading to real headaches even though the combat operations at that time were relatively minor but important. Gradually, it improved but never really became truly joint or combined. There was not much programming to solve the overall shipping problem ultimately assigned mostly to the Navy. The Army agreed to supply all forces with common subsistence materiel, and that worked satisfactorily although never with the full agreement of all troops or sailors. There was exceptional success with the Navy's operation of the total petroleum supply system and supply of compressed gasses.

At the unit level, in the Pacific and elsewhere, there was a lot of joint action and combined effort. The Navy's construction battalions and Army Air Forces units, for example, seemed to get along very well and cooperated readily and easily with effectiveness. There was, of course, a lot of joint, cooperative operation of airfields, roads, and other segments of the infrastructure.

Naval logistics in the Pacific was a major problem. Distances were vast. Practically all supplies had to be moved great distances under harsh conditions. The islands were remote, and except for Fiji, New Zealand, and Australia, there was really no adequate infrastructure. Therefore, the logisticians had to consider developing ports; building roads, ship repair yards, and medical facilities; placing communications lines; security installations; and so forth. All of this demanded huge new fleets just to get the required materiel (food, petroleum, munitions, medicines, and the like) to areas of need rapidly.

For example, by mid-1943, the Navy base at Espiritu Santo, New Hebrides, was the principal base in the South Pacific. It had been built in a hurry from nothing. Yet by this time, its aircraft engine shop was overhauling 200 engines per month; the torpedo shop was handling 6 torpedoes a day; the ship repair had fully housed facilities for complete ship repair capability; supply warehousing was in 36 buildings, each 4,000 square feet; there were 8 dispensaries and a 600-bed hospital; there was an active theater-wide postal facility; and there was a functional finance center for troop payment (37).

Logistics planning differed from theater to theater because requirements were obviously different. Europe was a landmass and predominantly an Army operation. It planned for only three major amphibious operations: North Africa, south of Italy, and Normandy. The Pacific theater was predominantly water and mostly a Navy operation. It covered huge territorial areas and encompassed a large number of amphibious operations of both major and minor impact. The China-Burma-India theater was a landmass with continental distances, impenetrable jungle, and tremendous mountain ranges. It was predominantly an Army operation with a great number of problems with the Allies. It became principally a holding operation with massive supply problems. Other theaters presented their own defined problems such as would be found in the Alaska-Aleutians or in the Middle East or in Central and South America.

The differences in the theaters can be described as follows:

- The European theater stretched from North Africa through the Northern European Continent. Planning was extensive, and each operation seemed to learn well from the experiences of the earlier. There was reasonably close coordination between the Allies as well as between the US Army, Navy, and Merchant Marinse. Most of the planning, including logistics, was combined (US Army, US Navy, and British), and generally all used the same policies and directives.
- The China-Burma-India theater suffered from the extremely long and difficult supply pipeline and a seemingly never-ending conflict of personalities and politics. It was very hard to supply the troops. There was no overall command of significance, and there was continual disagreement over airlift support, mission, and authority. It was, effectively, a loose, do-it-yourself operation of holding territory rather than being aggressive, except for occasional spirit.
- The Pacific theaters (there were several, in reality) also suffered from long and difficult supply pipelines. To a large extent, the Allies and Services acted separately and often tried to act independently. Combined actions were limited, as were joint actions, until mid-war. Each Service and country used its own policies, doctrines, concepts, and techniques. There was a great deal of conflict between the US Army and US Navy accompanied by dissension. There was no effective overall functional command although, at times, the action gave urgency to one Service or the other.

The other theaters were important, of course, but necessarily of lesser concern because they experienced little active combat. For the most part, they acted in defensive, patrol mode, and general, but loose cooperation was present.

Logistics planning for these theaters of operation was a vast and complex task. The minimal coordination and cooperation with logistics did very little to help, yet the job did get done as we have emphasized, although at greater expense than needed. Nevertheless, overall it was successful. As an example, we might quickly review the Allied landing at Normandy for the invasion of the European Continent.

The invasion of Normandy in June 1944 was the largest amphibious operation in history. The logistics support was unbelievable in magnitude. Keeping in mind the definition of logistics used in this text, we can see logistics at work planning for and providing:

- 5,000 fighter aircraft, USAAF and RAF.
- 3,500 heavy bombers, mostly USAAF.
- 1,600 light and medium bombers of both countries.
- 2,300 transport aircraft from all the Allies.
- 14,000 sorties to be flown on D-day with the bombers dropping more than 12,000 tons of explosives.
- 6 battleships from Allied navies.
- 23 cruisers.
- 122 destroyers.
- 360 PT (patrol torpedo) boats.
- 6,500 transports and landing craft.
- Hundreds of smaller vessels of various descriptions.
- Landing and supporting more than 176,000 assault troops in the first 24 hours (94:321).

The US Navy's role in this operation required very extensive logistical planning, which was constantly practiced in the months preceding the invasion. These practices invariably resulted in modifications of the planning and changes in requirements. But the vessels taking part had to be prepared with attention given to necessary maintenance before D-day as well as after. The maintenance attention was essential to ensure the vessels were combat ready and able to perform their part of the operational and logistics support plans. All ships had to be supplied with food for the crews as well as for the troops and passengers they would carry to and from Normandy's beaches. Ammunition to meet the planned firing schedules for assault support had to be provided all vessels. Plus, of course, extra ammunition had to be onloaded when the vessel was to provide offshore replenishment supplies to the assault forces. Various forms of petroleum products had to be taken aboard along with medical supplies and evacuation supplies. The fire-fighting and salvage crews had to practice and prepare for fast response to combat needs. There was more, naturally, but this should serve to identify the complexity.

So, a broad, yet detailed, logistics plan gradually evolved that would provide essential guidance but yet allow flexibility as the invasion proceeded. Obviously, the loss of vessels had to be taken into account, although no one could predict which ships would be lost and when. So a large part of the planning covered the contingency roles of the vessels in event certain other vessels were lost to enemy action, accident, weather, or whatever. All of that emphasized the need for flexibility in recognition of man's inability to accurately forecast the immediate effects of the coming combat. It was good that it was planned this way because necessity made for many new problems.

As D-day progressed, the Navy found it had to perform more base construction than planned in order to do essential loading and unloading. Ammunition shortages seemed in some areas to require certain supplying vessels to be shifted to meet needs. Unforeseen supply demands arose with short notice and unusually high urgency. Extensive maintenance, repair, and salvage of onsite vessels were required to keep fleet support available. It was a massive undertaking, which Navy logistics supported in an effective and commendable manner. The logistics planning had paid off (36).

In preparation for the invasion, the Navy established a range of English bases from which to work. The key base was a supply operation at Exeter that was constructed in just 4 months of almost continual cold rain and mud. They built 176 buildings to house personnel, a 36-bed dispensary, and 109 large buildings for storage/repair, among other structures. They also established two spare parts depots to support units and direct-to-ship supply systems.

Most of the construction was done by US Navy construction battalions (CBs or *Seabees*) using approximately 11,000 craftsmen and 350 officers. Their overall task included construction of:

- Housing to support 300,000 men and 2,500 officers of the US Navy.
- 1 million square feet of industrial work space.
- Untold numbers of radar and signal towers.
- Harbor walls and more than 50 landing ramps that were sloping causeways from below low-tide level up to roadways. Each such ramp could berth up to 14 LSTs at one time.
- Ammunition storage of more than 310,000 cubic feet, which experienced constant input and output as practice and supply actions took place (36:367).

Figure 1 reflects a very generalized recap of some of the more important parts of the US Navy logistics support plan for another invasion—the invasion of Italy earlier in the year. The objective of this figure is only to emphasize the urgent need existing at all times for communication, coordination, and cooperation in logistics planning. None of this could be effective without the 3Cs functioning (36:266).

As the war progressed and we learned, we found that logistics planning belonged in the highest echelons of military planning. The best military minds began to espouse equality among strategy, tactics, and logistics, but it was too late for the marriage of operational planning and logistics planning for most of the war and its execution. Because of this, much needless effort and expense were experienced. Very often, it was learned too late that strategic or tactical plans could not be adequately supported because logistics had been involved too late (148). Even in those instances where logistics had been included, the planning was incomplete because of the reluctance of operational people to accept logisticians as anything other than bean counters.

A late war example might serve to illustrate the problem. In the spring of 1945, recognizing the war in Europe was

close to ending, the USAAF strategic planners developed a program for the deployment of aircraft to the Pacific following the defeat of Germany. The program was unilaterally planned, and logistics personnel did not get to evaluate it until after it was completed. A logistics planning analysis showed the available Pacific airbases, plus all those in development, could not accommodate the numbers and types of aircraft planned to deploy almost at one time. Based on that analysis, the USAAF reconsidered and reworked the program, but all the manufacturing of the excess, unusable aircraft was wasted. It doesn't pay to do these things without the 3Cs or without logistics involvement.

Regardless of planning and coordination, in war there will always be excesses and shortages. It is impossible, given our current knowledge base, to accurately predict all needs and events. What we must work for, of course, is the minimizing of excesses and shortages because both are wastes of critical resources. Therefore, foremost in the minds of logistics planners must be, first, creation of the required military capability and, second, economy. A significant element of economy in logistics is the idea of utility value. To have utility value, a resource must be in the right form at the right time in the right quantity with the right quality at the right place (202:37). The wasteful use of resources, either materiel or human, has no place in military strategic, tactical, or logistical planning. If permitted to exist, such waste might well be fatal to the nation's efforts to survive and grow.

Logistics can become strategy when it is considered in offensive strategic planning. There is no real goal for attack other than to destroy the enemy's military capability. What produces military capability? Logistics. Therefore, the tactics and the strategy of attack are directed to eliminating the logistics strength of the enemy, and logistics of the enemy becomes strategy for us.

For example, in early 1944, the Allies were fighting a tough and very experienced German Army in Italy under Field Marshal Albert Kesselring. The going was rough because the Germans were excellent fighters and the mountains made attack difficult. General Jacob Devers, who headed all American field forces (including the air forces) in Italy and North Africa, decided to destroy Kesselring's logistics support. The Allies knew Kesselring required about 4,000 tons of supplies a day to support his 18 divisions when not in battle and 5,000 tons a day when being attacked or on the offensive.

The supplies came south to Kesselring via rail, road, and coastal shipping. The Twelfth Air Force, the tactical air force of the Mediterranean theater, attacked the logistics chain with all available aircraft. The Fifteenth Air Force, the strategic air force of the theater, participated by bombing German airfields and port facilities. Rail lines were cut in as many places as possible. More important, bridges were destroyed, tunnels were blocked, and viaducts were collapsed making repairs more difficult and time consuming. As the Germans hurried to rebuild or repair these damaged necessities, the Allied air revisited and again destroyed them. Ships along the coastal waters were sunk and ports effectively closed. There was practically no air opposition because the Twelfth Air Force destroyed airfields and aircraft. It came down to truck supply as the only available transport for the essential materiel. The German drivers often refused to drive in daylight because that meant certain strafing and probable injury or death. Twelfth Air Force tactical fighters closely patrolled the main roads so the trucks had to use the bad secondary roads, which slowed traffic and delayed support. Only a small quantity of needed war materiel made it through to the 18 German divisions.

When General Devers began his assault on 11 May, the forces of Kesselring were in dire straits. They did not have the logistics support they needed for effective resistance. The line collapsed, and the Allies took Rome. The end of the German hold on Italy was closer because logistics had become strategy.

As we gained victory after victory in the various theaters, we learned new problems for logistics resolution. Occupied territories raised the demand for some form of government and governmental services. There was a need for administering

US Naval Support of the Invasion of Italy

Fuel: Shore stocks of fuel located at Algiers, Bone, Bizerte, Malta, Tripoli, Palermo, and Augusta. Diesel at all except Bone and Tripoli. Gasoline (80, 87, 100 octane) at Bizerte and Palermo. Coal at Algiers, Bone, and others. All combatant ships ordered to fuel facilities to ease strain on tankers in assault areas.
Water: Drinking water strictly rationed all ships and craft. Ships with distillers must operate them to keep all potable and feedwater tanks to capacity at all times. Thirteen US LSTs altered to provide potable water to Army shore tankage. Water boats come to beaches or ports as required.
Provisions: Fill stocks before departure. Should not require all stock before opportunity to reprovision on return to bases. US Army to supply dry provisions and most cold storage products to all units plus Navy ships.
Clothing: Emergency clothing stocks available at Palermo, Bizerte, Malta, Oran, and eventually Naples.
Pontoon Drydocks: A number of 250-ton and 350-ton pontoon drydocks available and ready for LSTs, PTs, LCIs, and other craft.
Ship Repair: US repair ships will be at Bizerte and Algiers. British repair ships at Algiers and Ferryville.
Salvage: Tugs and salvage ships, plus harbor clearance parties, available at various sites.
Ammunition: Principal reserves at Bizerte, Oran, and in the ammunition ship *Mount Baker*. Minor reserves at Palermo, Arzew, Tunis, Tenes.
Medical: Medical sections provided for beach parties, ambulance boats identified, evacuation ships named, hospital facilities on friendly shores listed.

Note: It is emphasized this is a generalized recap of a detailed logistics annex to a major operations plan. Details could not be covered here. A lot has been omitted. The objective is to depict the complexity and need for communication, coordination, and cooperation.

Source: (36:266)

Figure 1. General Outline of Logistics Support

the needs of the population and avoiding riots and gang warfare. The occupied lands and the people needed foodstuffs, fuel, medical support, and a host of other assistance. These problems became the logistics planning problems of the Allied occupying forces. Logistics had not only the task of supporting our combat forces but also the added task of reconstructing the occupied lands and renewing their economies for the benefit of the people and the world. In the highest traditions of American charitable instincts, the US military accepted these tasks and energetically helped the defeated people to reenter the society of man in a beneficial manner. The logistics planning for military government operation became an effective peacetime-keeping factor in postwar politics and in the growth of postwar economies. Logistics planning proved its worth in reconstituting the ravaged lands of Europe and Asia.

Not all planned events worked well. That should be expected, of course, because even the best laid plans of mice and men often go astray. Certainly, in an activity as massive and as widespread as World War II, the planning was sure to be inadequate at times. Because of this and since there really was no way to ensure that all required resources would get to all locations when needed, there was a lot of improvisation by US forces worldwide. After the fact, of course, this is praised, and people are proud of what they did under the circumstances. And they have a right to be proud. At the same time, very often the need to improvise demanded time, skills, manpower, and materials that were sorely needed in other tasks.

For example, the 67th Fighter Squadron, actively engaged in combat in late 1942 on Guadalcanal, had to have the pilots do their own maintenance because maintenance personnel were not available. Neither were essential replacement parts that would have helped the pilots. The pilots did their best, but a number of problems surfaced because they were not really competent in these forced tasks. Poorly performed maintenance resulted in aircraft failures, some noncombat aircraft losses, and added danger for the pilots. There were hundreds of thousands of pounds of good parts and supplies somewhere in the system, but their locations were not known, and they could not be issued. There were maintenance personnel available in the South Pacific but not on Guadalcanal and not in the 67th Fighter Squadron.

At Noumea, New Caledonia, the offloading of ships was a problem not adequately considered in logistics planning until late in the war. The port condition, number of piers, and limited cargo-handling equipment led to long delays and much waiting. Very often in 1942 and 1943, ships waited in the harbor at Noumea for 6 to 8 weeks before they were offloaded and permitted to go on their way. At the same time, around the world, Allied forces were pleading for ships. Sometimes, when specific cargo was required, the manifests were examined and a ship might be moved to a pier for offloading of the specific materials wanted, and then the ship returned to its position in the waiting line. There were many questions about planning and about intelligence of planners, for understandable reasons. While this was going on, the ships were still being dispatched from the United States as though the Port of Noumea had no problems.

Some failures of logistics planning are well known. Most everyone knows of Patton's halted advances due to lack of fuel and munitions. Others were equally stymied as, for instance, on 1 September 1944, when General Eisenhower ordered the First and Third Armies to halt their drives because of a shortage of fuel. Each of those armies required more than 400,000 gallons of fuel per day, but fuel in that quantity could not be delivered for a number of reasons that the planners seemed not to consider.

The China-Burma-India theater of operations provided massive problems for logistics planners. The war was almost over before a fuel pipeline permitted adequate fuel support to forces in China. For most of the war, fuel had to be airlifted into China from India and Burma. This was accomplished by the famed *Hump Flyers.* Airlift was incapable of supporting all the needs, but the strategic and tactical planners would not attend to that constraint.

Active very heavy bombardment groups were moved into China to operate B-29 aircraft. The idea was to expose another element of the Japanese homeland and Japanese holdings in China to continued heavy bombardment. The B-29s could not be operationally supported with fuel flown over the Hump and were essentially grounded due to lack of fuel. The B-29 required 6,000 gallons of gasoline for a 1,200-mile flight. The transports bringing fuel over the Hump could carry only 1 gallon of gas for every 12 gallons they consumed. Only the barest essential fuel could be provided, and full operational use of the B-29 could not be supported (334:166).

On 4 December 1944, General Wedemeyer, commander of the American theater in China, asked for all B-29 aircraft and their operational units to be removed from China. It was, he said, too difficult to support them by air over the Himalayan Mountains. Thus, reality overtook planning one more time.

Planning for War's End

A major element of mobilization or wartime planning must be consideration for the end of hostilities. It is little known, even now, but there was considerable planning during the war by the Services for the time when the war would end. Much of this planning, but not all, was quite wise and farseeing. Plans were made for the termination of contracts and for some disposition of military equipment and materiel (317:80). The policy was to make everything possible available to the civilian economy to speed up the flow of production returning to meet civilian needs for goods and services (303:8).

When the war ended there was wholesale disposal of government-owned factories and other factories and facilities sold to businesses for conversion to civilian economy uses. Further, the government released machine tools to them for as little as 15 cents on the dollar. Because of this, the production of peacetime needs was almost immediate at the end of the war. As good as this was though, it had its bad side. The cheap release of machine tools caused more than 30 machine tool manufacturers to close for lack of business. By 1950, the US machine tool industry, once the world's greatest, was at only one-third its 1940 capacity (303:8). Nevertheless, the planned

actions for war's end probably ensured postwar prosperity where there could have been disaster without such planned preparation (148:220).

Planning for the phasedown and phaseout of military production actually began in 1943, and by the time of Germany's surrender (V-E Day) in 1945, it was pretty complete and ready. Massive materiel demobilization began with the announcement of Japan's agreement to surrender (V-J Day) in August 1945. Equipment destined for overseas movement and already at ports was stopped. Shipments to ports were stopped. Bulk supply shipments were stopped. Cargoes were opened and examined so decisions could be made about which items and how many should continue in shipment and which should be stopped or applied to demobilization (148:220-4).

Contract terminations were based on the Contracts Settlement Act of 1944, which aimed at terminations that were fair, fast, and final (148:220-4). This was a much better action than was that following World War I, which still had unsettled contracts as late as December 1941. Surplus equipment was processed through the Reconstruction Finance Corporation (RFC) for civilian use or salvage. For example, 35,000 aircraft went to RFC immediately following V-J Day, and an additional 33,000 went in June 1946. These included bombers, fighters, transports, trainers, and small aircraft from both Army and Navy.

Starting in June 1944, conferences were held with industry to explain to them the government's intent for fast contract termination and for equipment demobilization when the war ended. The Industrial College of the Armed Forces was reactivated in 1944 to train settlement teams. The Army Air Forces created special schools at Wright Field, Ohio, and Vandalia, Ohio. The Navy provided similar training efforts. Therefore, when the war ended, the Services were ready to terminate contracts quickly and efficiently. By mid-1946, most World War II contracts had been terminated and settled. The transformation from war to peacetime had been thoughtfully done for the most part with satisfaction by all principals (317:83).

However, as we shall see, no one seems to have anticipated the insistent demands of the soldiers, sailors, marines, and their families for their immediate return to the United States and release from service. This massive and very fast demobilization negated much of the careful planning for war's end because there often were no people left to activate and employ the plans. Further, probably billions of dollars worth of equipment and supplies were abandoned or lost through this hasty exodus and the inability of the Services to control property supplies. So although much effective planning for war's end was accomplished and some worked very well, there was an almost total collapse of military unit discipline and functioning with the end of the war. The plans became ineffective because of the unplanned actions that took place. It is an expensive lesson that logisticians should learn well as they plan for the potential of future wars.

Manpower

Manpower became an early economic logistics problem and continued so throughout the war. Conscription, the draft, bled much of the country's prime male population for military service. When reviewing this time, we must remember that the military, industry, and business were and had historically been predominantly male domains. Women were not generally accepted in these worlds until many of those managing these enterprises found there were no other employees available.

Even though it took so many of the able-bodied males, the Selective Service Act was widely accepted and generally approved by the people. Under the original act, all males 21 through 35 were required to register and were subject to being drafted. The change in the law in November 1942 lowered the registration age from 21 to 18, making several million additional males available. From 1940 to 1945, approximately 45 million registered, and 31 million were found qualified to serve in the Armed Forces. About 10 million were selected to serve, and additional millions were permitted to enlist without being drafted. Enlistments ceased in 1943 in complete reliance on the draft. The willingness of the young males (18 to 35 years of age) to register is reflected by the fact that only about 11,000 across the country were convicted of delinquency in either registering or reporting for service from October 1940 through 30 June 1944 (182).

Even so, we used our manpower unwisely and could have had serious manning problems in war production and military service had the war not gone so well for us. Fortunately, the war ended before our unwise manpower usage and policies could return to bite us. We avoided manning shortages and their resultant hardships with good fortune because we really had no effective plan for the full-scale manpower mobilization that was required. In October 1945, the Eberstadt Report to the Hoover Commission reported that due to lack of coordination, communication, and cooperation strategic plans were often not logistically evaluated until they were complete. Thus, the War Manpower Commission was never able to take part in the planning of requirements of the military for personnel. This resulted in incompatible and inadequate coordination of total manpower allocations (62:104).

Military induction involved four processes after the initial letter of selection from the local Draft Board. These were:

- A medical examination.
- Formal induction.
- Classification.
- Initial assignment.

The medical examination consisted of evaluation in six primary physical characteristics: stamina, hearing, eyesight, motion and efficiency of upper extremities, motion and efficiency of lower extremities, and neuropsychiatric evaluation. In each of these characteristics, there were four grades. The first two grades were accepted for general service and worldwide duty availability. Grade three was satisfactory for limited service, which meant assignments short of worldwide utility. A person predominantly found to be in grade

four was disqualified for military service. The classification of limited service was eliminated in July 1943, after which time the last two grades disqualified a man for military service.

The classification process involved the application of a series of tests to a determine man's ability to learn and his intelligence, skills and talents, affinity for certain trades, and so forth. From this came a general assignment to a job grouping in the military. From this, as far as practical, came the initial assignment. The induction sites did try very hard to assign people according to the classification findings. However, the urgencies of the war manpower situation at the moment dictated assignments very often, and classification was not observed. After all, very few people would probably come through classification particularly qualified for infantry duty rather than mechanic, typist, cook, or whatever. Yet infantry troops were constantly in strong demand, as were artillery and other combat duties in the Army and the Navy. Nevertheless, not all registrants met the standards.

For example, 5 million draft age men were rejected as *unable to contribute* after 1943 based on the idea every member of the Armed Forces had to be able to do everything, anywhere in the world. Thus, there was little or no consideration given to the practicality of selectively using slightly less than *perfect* people in the jobs that did not demand perfect physical or mental condition. Nor was consideration given to using these *less than perfect* individuals in US sites, allowing the more able-bodied to proceed overseas. Additionally, 1.5 million were discharged from the Army and Navy for disability under the same rationale that demanded perfect physical condition regardless of job or location (182).

Great numbers of those registered were deferred from military service for various reasons, such as:

- Occupational deferments in which the person was determined essential for farming, war production, civilian control agencies, or national defense programs.
- The person was needed at home because of the reliance of certain dependents on their nearness.
- The person held a position as a government official or minister or was an alien.
- The person was unfit to serve in the Armed Forces for physical, mental, or moral reasons.
- The person was a conscientious objector.

Conscientious objectors were of two general groups:

- Those who were members of historically peacetime churches. Their beliefs were well known and had never been doubted.
- Those with a general religious opposition to war. Their beliefs probably had never before been announced, there had been no need, and therefore, were not so well known. These people seemed to be held in some doubt by many people.

The conscientious objectors were routinely fairly treated by the general population. However, some were not, but they were usually from the second grouping whose beliefs had not heretofore been expressed. Commanding officers were given the option of assignment in the military to noncombatant duties, usually in medical or chaplain functions, or unpaid civilian service in work camps established by the peacetime churches. Many of those who accepted military noncombatant duties performed exceptionally well. Many of them were in actual combat in their assignments and won medals for heroism and performance under fire. One, I believe, won the Medal of Honor.

In total, only 5,500 conscientious objectors were imprisoned during the war. All the others—and there is no firm figure for the total—either accepted one of the two assignments mentioned above or put aside their beliefs and permitted themselves to be drafted. Some did this because of the apparently overwhelming sense of disgust with the Japanese attack and information leaking out of Germany about the Nazi treatment of non-Aryans. They seemed to want to do their part to defeat the Axis Powers and Japan (1:159).

Close to 18 million people served in the US military during World War II. Of these, 62 percent were drafted. About 6.5 million men were found to be unqualified to serve for one reason or another. The average time in service was 33 months. More than 7.5 million served overseas, averaging a bit more than 16 months in foreign assignments. Almost 40 percent of those who served in enlisted status were in rear echelon assignments such as administrative, technical, support, and manual labor classifications (Table 5).

As the military began to expand in 1940, there was a growing need for officers for leadership positions. In the summer of 1941, the first Officer Training Schools (OTS) and Officer Candidate Schools (OCS) were established to quickly train men and later women, as well, for commissioned roles. The graduates became the famed *90-day wonders* of truth and fiction. This was rapidly expanded, and by the spring of 1942, the program called for approximately 100,000 to be commissioned by way of OCS in the United States and overseas in Britain and Australia.

But these programs could not meet the Army and Navy needs for officers in certain qualifications, so direct commissions from civilian life were given to many. These men were predominantly professional people such as medical doctors, dentists, chaplains, and lawyers. However, in the rush to do this and in the urgency of the time, many problems were created. The worst problem was the weeding out of incompetents after they had come to active duty in their new commissions. In many cases, the officer procurement boards relied almost solely upon letters of recommendation. Occasionally, though, the letter of recommendation solved the problem before it had a chance to exist. For example, observe the following letter from a bank executive about the candidacy of a West Texas county judge:

> . . . the old gentleman was a pretty good guy in his day, but he has approached the age of senility, in addition to which he is probably the laziest man in West Texas. Although he is a veteran of the Spanish War, he still has ideas about his prowess and is constantly chasing blondes. He drinks a case of Budweiser everyday and

	Army	Navy	Marines	Total
1939	189,839	125,202	19,432	334,473
1941	1,462,315	284,427	54,359	1,801,101
1945	8,267,958	3,380,817	474,680	12,123,455

Note: Army figures include the Army Air Forces.

Table 5. Military Manpower

his wife has to put him to bed every night. The least said about his honesty and ability is too much. If the Army can find any use for this old bastard, they're welcome to him (159:100-1).

Not many letters of recommendation were so honest. The majority of those selected for direct commissions served ably and effectively, but there were some serious problems that created greater problems for the Services.

Blacks in the War

The conditions of American society prior to and during the war were not good for the black citizen. Blacks had been hit at least as hard, probably harder, in the Depression and its unemployment. In general, their lives were rough. Under the *separate but equal* policies of the federal government, many were given the opportunity for only a minimal education further reducing their opportunities for improving their circumstances. Segregation was practiced in civilian life as well as in the military, and it was harsher in the South where a great many of the new military bases were constructed. In 1940, for example, blacks were not permitted in the Army Air Corps or the Marine Corps. That changed, but until late in the war, blacks were only assigned to black units, which were mostly led by white officers.

Black pilots were trained at Tuskegee Institute in Alabama, starting in November 1941 and then assigned to black organizations. They served as fighter pilots, with honor and distinction, in the North African areas and in the Southern Europe. Yet even with all their training and demonstrated competence, they often experienced rather harsh segregation and treatment by their white contemporaries. For example, they were often not permitted to use the officers clubs because "those clubs were for white officers." Several near riots and some extensive investigations of mistreatment solved the basic problem and eased conditions by late 1944 and early 1945 in the Army Air Forces.

For the early years, blacks in the US Army were predominantly assigned to engineer and quartermaster units as labor troops, stevedores, and drivers. Except for officers, many truck companies in the Army were totally manned by blacks. The Secretary of War fostered the white officer condition because he said he believed black troops would fight well under white officers. General Marshall, Army Chief of Staff, thought it difficult to put blacks in technical branches because of "their relatively low intelligence averages" (129:92-3). By war's end, the Army was finding the black soldiers a valuable manpower resource and had begun using them with greater skill and attention to capability.

In the Navy, blacks were primarily assigned to duty as mess stewards until late 1942 when blacks began moving into other positions and doing well. But segregation in the Navy continued until late in the war when the Navy successfully experimented with integrated crews on 25 ships (1:161). The experiment was successful, but desegregation did not follow immediately.

On 27 May 1943, the War Production Board directed that all contractors involved in war production for the United States be prohibited from practicing racial discrimination. Thus, blacks were at least given legal right to any jobs for which they could qualify. Other actions were also taken to recognize the black citizen. On 25 July 1943, the *USS Harmon,* a destroyer, was launched and was the first US Navy ship to be named for a black. Leonard Roy Harmon had been a mess attendant who was killed while saving the life of a shipmate during the fight for Guadalcanal. He was awarded the Navy Cross posthumously.

In January 1944, 16 black officer candidates, all with prior enlisted naval service, were provided a special training course at Great Lakes Naval Training Center, Illinois. Thirteen of these men became the first large group of black naval officers when 12 were commissioned as ensigns and 1 as a warrant officer. Even at this late date and despite their commissions, they found segregation their lot. They could not live in the bachelor officer quarters and were not supposed to use the officers club and messes. White officers and white enlisted men did not accept them at first. However they persisted, did their jobs with skill and determination, earned respect, and became accepted members of the US Navy.

Racial incidents were experienced on military installations and in nearby towns throughout the war. As the segregation bans were slowly and partially dropped, the emotions of racial conflict seemed to become more heated. While the Services moved slowly toward desegregation and integration, too slowly for many blacks but too fast for many whites, the opportunity for the black citizen became greater. When the end of the war was nearing, conditions were noticeably changing because the military had learned segregation hurt the overall effort. The philosophy wasted manpower, lowered unit effectiveness, and created unnecessary tensions. The time ahead looked promising, but all in all, the use of the black citizen left much to be desired (1:163).

Women in the War

In recognition of the manpower problem and the force of patriotism in the country, in May 1942, the War Department was authorized to begin accepting women for the Women's Army Auxiliary Corps (WAAC), which later lost the *Auxiliary* and became the WAC. In December that year, the Navy began accepting females for Women Appointed for Voluntary Emergency Service (WAVES). Later, the women of the Marines and women of the Coast Guard also were authorized. The commissioned and enlisted women of the four Services served

in many jobs at many sites in the United States and around the world.

While not assigned to combat units, some did get assigned to combat areas and served well. In fact, the record of the women in the service was superb in all respects. Unfortunately, the social morals of the time caused some of the populace to consider the females who entered the military as *loose* women, and in some parts of the country, the women found themselves unwelcome in commercial establishments such as hotels, restaurants, and bars. Over time, this condition became the exception, and the women were recognized for the outstanding contributions they were making. They served in a great many different specialties in all the Services. In illustration, in late 1942, an Army evaluation of military occupational specialties showed that women could effectively serve in 406 of the Army's 628 identified military occupational specialty positions (55:508).

The idea of women in the military was not an idea that the military hierarchy eagerly accepted. Despite the high probability of manpower constraints, the higher levels of the military resisted the idea. In these years prior to the war, unemployed women were available in great numbers. Even after the war began for the United States, in early 1942, there were 19 million women between the ages of 20 and 60 not gainfully employed (55:503).

Women's organizations pushed hard for a role in national defense. In the spring of 1941, Representative Edith Nourse Rogers of Massachusetts advised General Marshall she intended to introduce a bill establishing a women's army corps. The Army general staff, feeling they could no longer avoid the issue or deny it, hurried to outline a framework of a female army corps that would "meet with War Department approval, so that when it is forced on us, as it undoubtedly will be, we shall be able to run it our way" (55:505).

After the war, with no reference to his earlier opposition to women in the military, General Eisenhower, in his book *Crusade in Europe*, said, "From the day they first reached us, their reputation as an efficient, effective corps continued to grow." The number of women grew through the war, although the number in uniform never did equal the planned numbers. Even so, the WAC peaked at 100,000 women with approximately one-half serving in the Army Air Forces.

Not in the military but serving the Army Air Forces were the ladies of the Women's Airforce Service Pilots (WASP). These women, all qualified and licensed pilots, wore specially designed uniforms and ferried aircraft to ports of embarkation, served as instructor pilots, and flew transport aircraft moving people and cargo. They served with great ability and helped to overcome manpower shortages in skilled areas. But they were never made an official part of the military services during the war. They came into being with the activation of the Women's Auxiliary Ferrying Squadron (WAFS) at New Castle, Delaware, in September 1942. The following August, the WAFS and women in pilot training became the WASP but still not officially part of the military (55:529-30). Rather, they were managed and paid similar to civil service employees. They lived in officers quarters on the bases, ate in officers messes and clubs, but they never achieved integration into the Services.

More than 25,000 women applied for pilot training with this group, and 1,830 were selected for admittance to training. More than 1,000 of them completed the training and were assigned to operational flying duties. They flew just about every type of aircraft the Army Air Forces had assigned, but their flights were essentially all in the United States and adjacent airspace. They flew ferry missions, tracking and searchlight missions, radio-control missions, instrument instruction missions, administrative flight missions, target towing missions, and flight test missions. Ferrying was the principal mission though, and they flew ferry missions for 77 aircraft types ranging from the P-38, P-39, and P-40 through the C-47, C-54, C-46, to the B-24. In 27 months, they flew 12,650 aircraft movements for a total of approximately 9.5 million miles. They were disbanded in December 1944 after a significant, but short, career of flight service to the United States (55:532-6).

Other women had long served as nurses in the Services in medical units and continued to do so throughout the war. The nurses were literally angels of mercy to the wounded and sick at military hospitals all around the globe. In many locations, the nurses were inadvertently in combat action because of enemy advances. Some were taken as prisoners of war; others were wounded or killed when their hospitals were overrun or became the focus of military action. For example, such was the case for nurses in the Philippines in 1942. For 3-1/2 years, as prisoners of war in the Philippine Islands, the nurses continued to serve the troops as best they could with limited or nonexistent medicines and supplies. There were 81 of these brave, heroic women (67 Army nurses, 2 dietitians, 1 physical therapist, and 11 Navy nurses). Their amazing stamina and courage made them the unsung heroines of World War II.

The flight nurses of World War II must be mentioned. They were the pioneers in the creation of a new skill, and their service in both the Army and the Navy was superb. Many were exposed to unusual hardships and combat dangers as they flew into and out of patient pickup points practically on the combat line. Their medical skills were significant contributions to the low mortality rate among US battle casualties, the lowest in US military history.

In summary, women in the military were a real boon. They performed their jobs with great skill and dedication. They always seemed to look their best, even in the worst of conditions, and it was generally agreed they made their male counterparts look pretty sad. They maintained high morale in most sites, and their morale overseas was superb. They had fewer health problems than their male contemporaries, and the statistics reflect the sick rate for women was only about 60 percent of that for males. They had no major problems of adjustment with the possible exception of service in the islands of the South and Southwest Pacific where inadequate housing and the hot, extremely humid climate paired to create morale, health, and appearance problems. Nevertheless, they more than did their share, and the military would have suffered without their aid.

Glenn L. Martin Aircraft Factory, Baltimore, Maryland, woman riveter working on the after fuselage of a *PBM Mariner* patrol bomber, February 1943. Photographed by Jacobs. (Courtesy of National Archives)

In the civilian industrial and business world, the women became a mainstay of the war effort. *Rosie the Riveter* has become the popular representation of these women who moved out of their traditional home, teaching, nursing, and office jobs into the dirtier and more physically demanding jobs of production. Women proved then they were able to do just about any job men could do given some consideration for their physical and strength differences. In fact, in many instances, they could and did do jobs men could not do or had difficulty doing. For example, bucking rivets inside an aircraft wing panel or fuel tank demanded a size and dexterity that women had but men generally did not. Rosie the Riveter was of inestimable value to the United States and its Allies. Without her, the war production would have suffered and the war could not have been pursued so strongly. By late 1943, women made up one-third the aircraft production work force in the United States when there were more than 478,000 women working in the aircraft industries. In one parachute company, for another example, women constituted 85 percent of the total work force in 1944. Without doubt, women were key elements of the industries that produced the weapons enabling the Allied victory over Germany, Italy, and Japan.

Merchant Marine

Although never recognized in any manner as part of the US military effort of World War II, the merchant marine served with distinction and bravery. There were thousands of civilian ships' crewmembers sailing all the oceans of the world, under all forms of danger, to deliver manpower and materiel resources (including ammunition, fuels and oil, and other dangerous cargos) to military and civilian consignees. These are the forgotten heroes of World War II because they have never been recognized by the government or the people of the United States for all they did.

Most of the US flag shipping in World War II was manned and the cargo, no matter how hazardous, delivered by these civilian members of the ships' crews. They were exposed to the horrible dangers of the North Atlantic where navy U-boats and nasty weather destroyed literally hundreds of ships and their crews. They sailed into the Arctic Seas to ensure cargo delivery to established and temporary ports. They crossed the Pacific with the constant threat of Japanese submarines and participated in assault action since they were part of the delivering convoy. Wherever they were needed, they served with little regard for the danger involved.

The military logistics requirements of the war could not have been met without the effectiveness of the heroic merchant marines. We owe them much. We also owe much to the US Navy gun crews that served on these vessels wherever required. They were all heroic in their work, and their accomplishments were a significant contribution to our ultimate victory.

Civilian Labor in the Military

War and Navy Department policy required the maximum use of civilians in depot and subdepot jobs to free military personnel for overseas assignments. The Services struggled to meet this requirement, but they found it difficult because they had no real hold on their employees. As the employees received training and became skilled at their jobs, they tended to move with their acquired skills to the better paying jobs in civilian industry doing war production. This was legal so long as the new job was war essential. So the depots had constant training and development problems throughout the war and no legal basis on which to hold their trained and more highly qualified people.

Flying and maintenance training were other specialties in which civilian labor was heavily used. Early in the war buildup, the Services decided they could not hope to use military manpower to operate their many flying and maintenance schools for all specialties. Highly qualified persons could not be retained for instructor duties because the demand for the skilled aviation specialists was too great in overseas combat units. So the decision was made to employ contract flying training schools using civilians who had commercial licenses and sufficient experience to be flight instructors and ground school instructors. The same was done for maintenance training, and many military personnel were trained in trade schools, newly created civilian training schools and some

colleges and universities. Much of the same was done for other specific specialties such as weather observers and forecasters, communications engineers, and so on. All of these efforts relieved the Services of a huge demand for highly skilled uniformed manpower in essentially nonmilitary jobs. The uniformed people were then available for overseas assignments where the civilians generally could not serve.

Women again were a mainstay in efforts to free military manpower for overseas assignments. In the Army Air Forces, for example, in 1943, women made up 45 percent of the total civil service strength. Many were performing jobs in depots doing propeller repair, component overhaul and repair, aircraft camouflage painting, equipment inspection, welding, machinist work, and sheet metal repair (55:539).

Industrial Mobilization

Industrial mobilization is a massive problem for any nation. It is even worse when being worked under the high stress of actual war. In reality, there are three sets of problems, and each problem set is huge in its own right. First, the nation must keep all essential civilian support functioning for the health and safety of the citizenry. This would include food supply, medical care, pharmaceuticals, and so forth. Second, industrial organizations must maintain production to satisfy peacetime procurements to equip the military forces and fill war reserve stockpiles. Third, mobilization actions must provide industrial capability to produce sufficient military materiel to meet requirements in the event of war and to expand overall production in situations short of war (303:2).

The United States met this challenge in World War II, and the industrial output in the United States for military goods (for our own forces and our Allies) reached 45 percent of the country's gross national product. During the war, we attained production rates exceeding 50,000 aircraft, 20,000 tanks, 80,000 artillery pieces, and 500,000 trucks per year, for example (303:2). This was an impressive record, but it becomes even more impressive when we recognize the war economy could have handled more military spending had that been necessary—there was still 55 percent of the gross national product not directly exercised in war production and spending.

Even so, it is of interest to note that logistics had to provide the means, through industrial mobilization, for raising, for example, aluminum production from 327 million pounds in 1939 to 1.8 billion pounds in 1943, steel ingot production from 53 million short tons in 1939 to 90 million short tons in 1944, machine tool production from $200 million in 1939 to $1.3 billion in 1942, and synthetic rubber production from 8,300 tons in 1941 to 800,000 tons in 1944 (148:16-19).

Other examples could add weight to the impressive record but are probably not needed now. The point is that it is not sufficient to have productive capability for war materiel unless effective planning accompanies that capability. That happened as we matured during World War II although, as we have discussed, there was a great deal of unilateral activity by the Services and a general omission of logistics from strategic and tactical planning in all the theaters other than for the European invasions.

The magnitude of the production efforts in World War II is frequently unknown or not really appreciated. Aircraft production was very large (nothing like it since then, of course), and even though we shipped a great many aircraft to our Allies, the number of aircraft on hand in the Army Air Forces was staggering. Table 6 reflects this amazing growth of aircraft availability. To this data must be added comparable data for the Navy since this reflects only the Army Air Forces.

Aircraft production during World War II is good material for extensive study in its own right. There is much to learn from this experience, but we have not the time for that now. Nonetheless, we should note the overall statistics. US production went from 2,100 aircraft in 1939 to 48,000 in 1942 to a peak of 96,359 in 1944 (31:140). This was an amazing accomplishment, but at the same time, the other belligerents were also producing aircraft. The total aircraft production shows the following:

- Britain 131,549
- Soviet Union 158,218
- United States 303,713
- Germany 119,871
- Japan 76,320

End Year	Total	Heavy Bomb	Medium & Light Bomb	Fighter	Recon	Trans	Train	Comm
1939	2,546	39	738	492	378	131	761	7
1940	3,961	92	639	625	404	124	2,069	8
1941	12,297	288	1,544	2,170	475	254	7,340	226
1942	33,304	2,079	3,757	5,303	468	1,857	17,044	2,796
1943	64,232	8,118	6,741	11,875	714	6,466	26,051	4,267
1944	72,726	13,790	9,169	17,198	1,804	10,456	17,060	3,249
1945	63,745	13,930	8,463	16,799	1,971	9,561	9,588	3,433**

** These figures are as of 31 August 1945.
In July 1944, The Army Air Forces reached its peak aircraft strength of 79,908 aircraft on hand (54:V6).

Table 6. US Army Air Forces Aircraft

We can see these five countries alone produced more than 789,000 aircraft in the 6 years of the war. More than 40 percent of the total came from the amazing industrial machinery of the United States.

The Battle Tank

During World War II, the tank became a major tool of attack and defense. The industrial bases of all combatants produced tanks, but the mobilized productive ability of US industry permitted us to outdo all others. Of course, we must keep in mind the other countries were longer engaged in actual warfare and eventually found themselves unable to supply all the military resources needed. The United States was fortunately able to fill the gap for the Allied forces fighting the Axis Powers and Japan. We produced three broad categories of tank—light, medium, and heavy. German tanks were usually recognized as superior, but the mass of our production overcame that feature.

But the United States was not always a tank producer. During the 15 years immediately following World War I, we produced only something like 35 tanks. And to make that even worse, each of those tanks was a different model as we tried to develop a suitable machine. That quality offered no field capability. After 1933, a few more tanks were built of one model, but in general, the United States had no tank production and no effective armor units until about 1941. That changed during the war, of course, and the change is reflected in Table 7.

American industry built tanks following the concepts it had developed for building automobiles—the production line. Most of the designers of buildings, tools, equipment, and process lines had never seen a tank and knew nothing about their actual working. Further, most of those who were told to design the first US-produced tanks were in the same fix and worked only from general discussions and photos from Europe. No matter, they did the job and produced great quantities, as indicated in Table 7, during the war. But all the tanks were not great products. The original light tanks (they were basically restricted to about 15 tons—theoretically so they could be moved by truck) proved inadequate for rough field use. The later medium and heavy tanks were much better, even though the German tanks often could beat them in some respects. Medium tanks started coming out of production in 1941 and the heavy tanks in late 1944. The tanks grew in size until the heaviest was about 65 tons at war's end.

With all the urgent need for tanks to supply US and Allied forces, there were many errors made. Designs were frequently changed, and specifications for such essentials as armor plating, turrets, and weapons were frequently altered. The result was a lack of configuration control, which led to production problems and added expenses plus later distribution, supply, and maintenance difficulty supporting the mixed bag of tanks in the field. Even so, the industrial base was able to meet and exceed its production targets, and ultimately, the changes were slowed, and control was attained. The early days, through 1943, were frustrating and expensive.

The Chrysler Corporation was a predominant supplier of tanks from the first days of the armament rush in June 1940, about 10 months following Germany's initiating the war in Europe. By all accounts, Chrysler (and the other manufacturers, as well as the hundreds of subcontractors and suppliers across the country) really did a great job, under enormous pressures, for speed and quantity. Before it was over, in addition to meeting its wartime production requirements, Chrysler returned to the government cash refunds and price reductions of more than $50 million dollars in 1940s values. It is said the corporation received only about $4 (yes, four dollars) for its designs and its planning efforts for US tank production in World War II. But then, this was a war almost every American supported and a war in which very few attempted to get rich at the government's expense.

Year	USA	Britain	Germany
1940	330	1,400	1,450
1941	4,100	4,800	3,300
1942	25,000	8,600	4,100
1943	29,500	7,500	6,100
1944	17,500	2,500	8,100
1945	12,000	—	1,000
Total	**88,430**	**24,800**	**24,050**

Note: Only the first 3 months of 1945 are included.

Source: (75)

Table 7. World War II Tank Production

The Patrol Torpedo Boat

Another important weapon system from American industrial processes was the PT boat used by the US, British, and Russian navies. More than 600 of these boats were manufactured by Elco, Huggins, Harbor, and Jacobs boat companies in yards around the country. Approximately 150 of the boats were provided Britain and Russia through lend-lease efforts.

The PT boat was 77 to 80 feet long, with the shorter version weighing 33 tons and the longer 38. The short boat had a speed of about 41 knots, while the longer was slightly faster at 43 knots. The boat was constructed of laminated spruce, white oak, and mahogany bulkheads, which were then covered with marine plywood for strength and water control. Hull planking was diagonal 1-by-6-inch mahogany boards. There were two layers of hull planking, with the top layer installed in opposite angle from the lower. The deck planking was also 1-by-6-inch mahogany laid bow to stern. The boat was built to take high speed and rough water although not with crew comfort.

Propulsion for the boat was from three Packard 12-cylinder marine engines, each producing about 1,500 horsepower. Fuel capacity was 3,000 gallons, which gave the boats a range of only about 500 miles. Therefore, to be effectively used, the boats had to be stationed at and operate from bases very near the enemy. They were, in other words, front-line weapons.

The original armament was two .50-caliber machineguns forward and one 20-millimeter gun on the aft deck. This was often changed by crews adding other guns or changing the size of guns. There were four torpedoes carried aboard. The early torpedoes were not very effective. The US Navy had not done much research or development for torpedoes between World War I and World War II. As a result, fuses were unreliable and often would not cause detonation unless they hit the target at a precise angle. Further, the torpedoes were not reliably directed or propelled. It was midway in the war before these problems were partially overcome. Meantime, the crews did a lot of local modification to permit the boats to carry more and bigger guns and home-modified torpedoes. Some South Pacific crews experimented with forms of depth charges to use in lieu of the torpedoes. All of these actions, while applauded for initiative, created further logistics support problems as each boat became unique.

The boats hit a romantic nerve in the American people. They were dashing weapons crossing the water with evident speed and maneuverability. Their overall value is somewhat in question, and by the end of 1945, only three PT boat squadrons remained active in the US Navy. By the end of 1946, only three boats were active. However, they did do a necessary job against coastal shipping, primarily, in the several theaters in which they worked. They were a worthy product of the industrial might of the United States (120).

Weapons Problems

In general, we can say that American design and production genius supplied the free world with the weapons of victory. Specific items such as the Jeep, C-47 aircraft, Liberty and Victory ships, PT boat, and many others served with distinction and were the engines of victory. But all was not so ideal. There were difficulties that extended beyond the mere troubles accompanying the introduction of a complex, new item of weaponry.

For example, many of the armored divisions considered the M4 Sherman tank a *death trap*. The Sherman had mechanical problems, but more important, it had long-term ordnance problems. It could not always fire and was often in action without firepower and became a trap for its crew. The overall problem was not fully resolved through the war.

The bazooka fired a 2.6-inch rocket that was generally classified inadequate for its intended purpose of destroying enemy tanks. It was designed as an infantry weapon to be used against the enemy tanks, but it could not destroy the German Panther or Tiger tanks. Infantry divisions used it because it was all they had, but they generally found it more effective against buildings and emplacements than against tanks.

Solomons Operations, 1943-1944, USS PT-174, operating with other PT boats from the Rendova base, central Solomons, January 1944.

Maneuvers of motor torpedo boats off an east coast port, 12 July 1942, USS PT-107. (Courtesy of National Archives)

The 4.5-inch rocket artillery turned out to be inaccurate and unreliable. When it worked, smoke and fire from the ignition revealed the weapon's position and made it a trap for its users. When used, the troops had to plan to *shoot and scoot* before the enemy could react with its own artillery fire. It was never able to perform as planned.

The War Production Board

Industrial production came under the control of the Office of Production Management (OPM) when Roosevelt created it in January 1941. While many arguments exist about the effectiveness of the OPM because of its limited authority, it did get war production started under some form of control and coordination. The War Production Board (WPB) replaced it in January 1942 with much stronger authority for resource priority assignment. The Services suspended competitive bidding and went to cost-plus-fixed-fee contracting, which ensured the contractor a controlled profit. To help industry convert to military production, the Services paid up to 30 percent of the contract cost in advance so the manufacturer would have financial capability. Further, they guaranteed to cover costs of retooling (1:35).

In a further step to speed up conversion to war production, the WPB curtailed the manufacturer of civilian products, which used scarce resources (such as automobiles, home appliances, lawnmowers, metal office furniture, and so on). Those businesses that manufactured such items had three choices: go out of business, manufacture some new product, or get into war production. Necessary resources were in short supply and controlled, so usually they were not able to go to manufacturing new products. Most did not want to quit, of course, so war production was the logical and patriotic thing to do, thus enlarging the industrial base and capacity. But the flow of new shops to manufacturing created additional problems as they vied for manpower, scarce tooling, controlled resources, and other elements of production (1:136).

There was considerable confusion about the WPB priorities and the military contract needs. Military need in those days following Pearl Harbor had an impressed urgency that gave impetus to the demands for resources. Further, new contracts were being let continually for new and growing quantities of war goods. Each such contract further added urgency to needs for resources, and there seemed no firm control over the burgeoning demands.

The resources (facilities, raw materiel, and manpower) were not finding their way into the system. But the WPB failed to exercise its authority over the military procurement efforts, and the Services continued to let contracts well in excess of industry's capacity. This was corrected in mid-1943 when the WPB initiated its Controlled Materiel Plan. Under this effort, the manufacturers were required each quarter to advise WPB of their needs, schedules, and stocks of controlled materiel. Concurrently, suppliers of controlled materiel reported their expected output and schedules. The WPB then allocated materiel, usually at lower quantities than requested, to the manufacturers from the scheduled supplier output. This system was, at last, a reasonable and fairly satisfactory system for controlling war production.

However, the WPB had serious flaws. It emphasized control of defense production when the entire economy, both civilian and military, needed and demanded attention and direction. The WPB also left most procurement to be done by the individual Services, which led to inadequate coordination with each other and with allied and civilian needs. It used a voluntaristic approach to business that emphasized profit incentives rather than tight central control and direction for the war production efforts. It permitted important parts of the industrial mobilization effort (such as petroleum, rubber, prices, and manpower) to fall under independent agencies for control rather than under its own central control. It created and demanded highly excessive paperwork of apparently little real value. It seemed to do little planning but instead to grope and experiment searching for effective means of control. It did finally, either by purposive action or by good fortune, succeed. The miracle of American production provided Allied victories over the Axis Powers and Japan and brought the war to an end (1:135-7).

Requirements Determination

Key to the creation and sustaining of military capability is the process of determining what will be required and when. This process is called requirements determination, and it is a very demanding, yet very inexact, effort. It is aimed at computing, in some manner, a quantity of an item to be required for a specific period. The computation must include factors such as:

- Quantity of initial issue of the item to using units.
- Replacement rates.
- Consumption statistics.
- Stockpile or storage quantities.
- Shipping losses probable.
- Losses in storage due to weather, environment, and theft.
- Quantities likely to be in the pipeline and pipeline or lead time.

From all this comes a quantity of the item or supply for a specific period. From that figure comes a production or procurement requirement of sufficient quantity to meet the forecasted overall need, including overcoming lead time.

These computations usually demand relatively explicit answers to questions such as: Will the item be expendable? Will the item be reparable and under what conditions? Who will repair it? What will be the expected repair turnaround time? What combat losses must be expected? What routine in-use losses might be expected? What shipping losses are probable? There might well be many more such questions to ask and answer if the computations are to be reasonably accurate.

Requirements determination in World War II was basically done as it had been in World War I and as it has been since. That is, it was done by an analysis of past consumption and extension of the past into the projected future. The problem, of course, was that there were great numbers of new items and

new weapons in World War II that had never before been used and for which there were no past consumption figures. Therefore, there were few bases from which to extend into the probable uses in this war.

For example, in May-June 1943, the United States made its first uses of chaff as a radar countermeasure. The chaff was small strips of thin paper coated with metal foil. It was ejected from an aircraft in small bundles that immediately separated into thousands of small foil-coated strips fluttering to earth slowly. The foil reflected the enemy radar and gave the radar images of great numbers of aircraft rather than just one. Further, the images allowed some freedom of movement, undetected, by the releasing aircraft. This was a promising new development adding to the safety of flight crews. But how long would the equipment last? What kinds of maintenance and how much would it require? What parts would be required? Will it jam and create new difficulties for the flight crews? How often will it be used, and how much will be expended over what timeframe? Will the chaff store satisfactorily in all climates? All of these questions, and more, had to be answered in some fashion if the new chaff and its dispensers were to be effectively procured, distributed, supported, and used. The questions were answered, and it was effective worldwide until the enemy found means to counter it.

Additionally, the war was so huge and the expansion of the military so great and so rapid the efforts at requirements determination were generally poorly done. Additionally, many of the people given the responsibility to compute requirements had no experience on which to draw. On the whole, the logistics processes did create most of what was needed for victory and accomplished an effective, but inexact and often wasteful, determination of requirements.

A major factor in satisfying requirements always is lead time. The problem of lead time is significant in military equipment. Most military weapon systems require long lead times for production and distribution. Most military materiel, because of its unique purpose and field of use, cannot be purchased off the shelf from civilian goods. There are many reasons for this, but we should note the rough use and so forth. So a major factor in all military requirement determinations must be lead time.

In World War II, requirements for major military combat or support operations had to be anticipated, requisitioned, and stored anywhere from 18 to 24 months in advance of need. However, it was relatively impossible for logistics people to obtain information about forthcoming operations with any kind of accuracy from the operational and planning offices. In many instances, those people really had no firm knowledge with which to work and could not provide the data required. In other instances, the operational people saw little need to coordinate or communicate with logistics planners and did their jobs more or less in isolation. As a result, logistics planners very often had to make assumptions on their own about coming operational events, often with little or no valid data or information (206:508). They obviously could only be correct by coincidence so many of the actions to meet requirements turned out to be faulty—either far too much or far too little. Neither is desirable, of course, but in the absence of any other data, logistics had to do something because the pipeline and lead time demanded action.

Therefore, logistics efforts to calculate requirements were often based on data generated by themselves and assumptions about forthcoming military operations. Much of this was well intended but actually was little more than guess since they were not always advised of the forthcoming actions. Further, the logistics people were not always informed of changes to the plans so they could neither calculate on firm basis nor make alterations to production schedules, shipping assignments, and the like. Additionally, since the logistics plans were often based on hunch and guess, they frequently differed greatly from actual events. This allowed little freedom to accommodate changes in operational events or the unexpected.

The complexity of the process and the often down-to-earth solution to a nettlesome problem may be illustrated by an example. The problem was to determine requirements for ground petroleum products (gasoline, oil, and greases) for specific military operations and for support of forces in given theaters of operation. Consumption figures for gasoline for the specific ground vehicles were available, of course. But the question was how to calculate combat and service force activity in actual combat. What vehicles would be used, for how long? How many of the vehicles would be lost or made inoperable? What quantities of fuel would be needed for electricity generators? For lanterns? For construction equipment? For stoves?

Great mathematical efforts were expended in an effort to solve this problem, but the general result was either a flood of gasoline or a severe shortage. What finally happened was a sharp planner noted a distinct relationship in the earlier operations between gasoline consumption and manpower strength. The consumption rate averaged about 1 gallon per man per day. Further, this relationship was relatively constant across all theaters of operation. Other ground petroleum products (motor oil, grease, diesel fuel, and so on) were easily related to the gasoline consumption, and the requirements determination problem was essentially solved. But to be useful, the logistics planners had to have information about manpower strength anticipated in the coming operation. This was another problem but one that could be handled easier than the first.

Very often, one requirement leads to many others because there is dependency involved. For example, consider the following brief development concerning just one B-24 Liberator, a four-engine heavy bomber of World War II. Manufacturing that one B-24 required many parts, material, engines, guns, instruments, and so forth, each a requirement to be computed and coordinated for action. The newly constructed aircraft on the ramp in Detroit represented thousands of man-hours and about a quarter of a million 1940 style dollars. But a bomber at the factory has no military value so we must move it to, say, the Eighth Air Force in England. That would require about 23 flying hours, a flight crew, and support en route. The B-24 consumed 210 gallons of high-test gasoline per flying hour, so we had to provide more than 4,800 gallons of gasoline at en route bases. In addition, of

course, there were airways and communication support, human needs support, and so forth.

Eighth Air Force records reflected the combat life of a B-24 to be approximately 237 days (about 700 flying hours). In England, over two-thirds of that year, the B-24 had to have more than 145,000 gallons of gasoline. Further, each B-24 spent, on average, almost 7 days in a depot during its combat life and 35 days in local repair of combat damage and wear. Thus, we had to have base and depot-level maintenance and supply people, facilities, equipment, tools, parts, and other resources. Each aircraft also required eight new overhauled engines in its short life, so the production and following repair, plus shipping for engine change support, had to be provided.

Figure 2. Aircraft Inventory

What is omitted from the above? Regular and recurring maintenance, airbase construction and maintenance, security, housing, feeding, chemical warfare preparation, and a host of other needs, all stemming from a requirement for one type of bomber. Think of the expanded problem when considering 15,500 heavy bombers (B-24s and B-17s) delivered to England and the Mediterranean area. The problem becomes very large and complex, yet we are discussing only one weapon system type: the heavy bombardment aircraft. The need for coordination, cooperation, and communication of operational planning between the operational planners and the logistics planners should be quite clear. The need is for the 3Cs well in advance of the actual requirement date because almost everything we have discussed relative to this problem has a very long lead time. But in World War II, the presence of the 3Cs between the operational and logistics people was the exception rather than the rule (Figure 2).

Procurement

During World War II, procurement was a tremendously large and intricate affair, which was generally carried out with great success, avoiding most of the scandals and price gouging experienced in World War I. The story of procurement is one of overall success even though occasionally inefficient. Procurement officials had nothing to say about determining requirements. They were expected to obtain that which others decided was needed. They did that job obtaining billions of items ranging from battleships to tanks to bullets to beans, from bombers to paper clips, from hospitals to safety pins. It is estimated they spent $316 billion in military procurement, production, and construction during the war. Of this total, $163 billion represents weapons, equipment, and supplies delivered to our military services and those of our Allies (23:55) (148:25-31). Examples of the procurements during the war run to astronomical numbers and diversity. Some were:

- 40 billion rounds small arms ammunition.
- 800,000 2-1/2 ton trucks.
- 270 million pairs of trousers (US Army, Navy, and Marines).
- 137 aircraft carriers.
- 310,000 aircraft (14:56).

World War II was a very large war, as we have discussed. We have already looked at some large figures attesting to the magnitude of the logistics job. Many people tend to think of procurement merely as paper shuffling and the handling of contracts. Those who do so fail to recognize the site inspection, qualification, quality assurance, and other task efforts of the procurement offices. The following figures are examples solely from the Army Service Forces and do not include the Air Forces, Navy, Marine Corps, or Coast Guard. They are provided only to again emphasize the enormity of World War II procurement.

- In just 1 month, March 1945, procurement deliveries to the ASF totaled more than $2 billion. In today's terms that would equate to more than $12 billion—in just 1 month.
- Medical deliveries during the war came to more than 31.5 million first-aid packets, more than 10 million surgical instruments, and 9,000 X-ray machines.
- Three and one-half years of procurement netted more than 800 million square feet of aircraft landing mats—most of it

pierced-steel planking; 1.2 million radio sets and 20,000 radar sets; 2 billion pounds of incendiary bombs; 11 million mortar shells; 41,000 flame throwers; 7 million rifles; 2.3 million trucks; and much, much more.

The point of these data is merely to drive home the scope of the task when huge military forces are deployed worldwide. Even if we were to experience a single-front war in the future, we must expect similar numbers. The logistics challenges for procurement will always be great as we wrestle with resource priorities and a host of contractors attempting to obtain the supplies and materiel required for strategic and tactical purposes.

Underlying the diversity and complexity of wartime procurements was the constant fighting over priorities for the use of strategic materiel, critical materiel, and production capacity. This was a cause for continuing conflict among the Services and conflict with our Allies for the entire war. Although the priorities conflict varied in intensity, it was constant. Everyone wanted his orders produced and shipped first, and the procurement officials were twisted and torn but were in no authoritative position to decide final priorities. This was up to the War Production Board. The WPB functioned and was successful, but many questioned its efficiency. Its action caused many complaints about delayed decisions, lack of priority control, and excessive paperwork.

Another large-scale procurement problem was standardization control. Production capability was often stretched by the quantities and delivery schedules. The absence of standardization of parts often worsened these conditions. It took time and courage for the procurement official to insist on the use of standard parts, argue as necessary with the design engineer, and plead with the customer for understanding and acceptance. Standard parts were essential for speedy mobilization of industry early in the war and for efficient production throughout the war. Further, standardization had beneficial effects for maintenance and supply in the field.

Specifications became the method of standardization, and the engineers at Wright Field for the Air Forces generally produced them, the Philadelphia Naval Aircraft Factory for Navy aviation, the Bureau of Ships for naval vessels and at various arsenals for the Army. A few government-wide specifications of general applicability also served advantageously. In addition, there were industry-wide standards created by professional associations or industry committees. It was necessary for the contracting officials to stay abreast of developmental progress in the industry so they could recommend changes to specifications and standards when necessary.

The need for standardization is readily recognized when one considers, for example, such commodities as guns, ammunition, bombs, radios, cameras, and instruments. For example, it would not be very beneficial for a unit in combat to receive, as its only supply, ammunition that would not fit its guns. Nor would it be of much help in the production of an aircraft to receive instruments that would not interface with instrument panels. Then, too, it was necessary for our Allies to agree to the standardization because much of the procurements were going to them. We could not afford to manufacture different configurations for them. We also received materiel and items from our Allies, and these, too, had to interface and fit.

Another significant problem, which finally faced the contracting officers, was contract termination. This was considered a special problem when we began to think about the probability of a Japanese surrender. The termination planning and efforts will be discussed later. However, it should be mentioned here because the planning for and execution of contract termination was so well performed at war's end. The procurement officials really have a great deal to be proud of in this regard.

Procurement officials had to be highly qualified to deal effectively with the civilian contractors, military requisitioners, and various control and priority groups. To fill their ranks, the Services relied on selective recruitment and training of contracting officers. They were selected based on their business experience, professional abilities, educational background, general intelligence, and demonstrated business acumen. Special courses were conducted for their training (23). For example, the Air Service Command created courses conducted by the Legal Branch at Wright Field, Ohio. In November 1943, that command published a document titled *Handbook for Contracting Officers*, which proved invaluable for training and procedural guidance (112). Later courses for contract termination were equally effective. The Navy followed similar selection processes and training programs for procurement officials.

Two types of contracts were predominantly used during the war. They were the fixed-price (lump sum) contract and the cost-plus-fixed-fee contract (23, 112, 119, 1:131-169).

> The fixed-price contract was the most frequently used. Under its provisions, the government and the contractor agreed to a set amount to be paid for delivery of a specified item or service, in certain quantities with certain quality. However, for it to be fair, the contracting officer had to have a wide knowledge of production costs, and this was not always available because often the contractor was being asked to do something never before done or to do something with entirely new materiel, on totally new products (23).
>
> The cost-plus-fixed-fee contract was helpful because there were often great numbers of changes to a contract during its life, and this contracting device permitted the contractor to recover his expenses and still earn a profit. In this contract, the government and the contractor agreed to certain conditions of delivery for which the contractor would recover his costs and, in addition, earn a set fee. That fee was either a specified sum or a percentage of costs. The legal limit was 7 percent, but the most frequent fee used was 5 percent. The Army Air Force's average fee for the war period was 4 percent of cost. This form of contract required close government audit of contractor expenses and costs plus

a partial government management control of the contractor (23).

The World War II procurement experience provides a fertile area for lessons to be learned. Three of the most significant are:

- It is essential the nation have unified, flexible, and effective industrial mobilization planning that recognizes mobilization may very well involve the entire economy.
- There must be a directing and coordinating organization prepared to innovatively act on the great variety of procurement problems likely to rise.
- The plans for mobilization and control must be implemented immediately when crises require such action. Delay can be fatal (23:61).

Distribution

Distribution was a huge challenge to logistics forces during World War II. The worldwide location of forces of the United States and its Allies made the movement of men, equipment, and supplies a major problem. The need for movement of these resources through common facilities and carriers forced a higher degree of coordination between the Services and in the Services than in any other element of logistics. Even so, there were difficulties that might have been avoided through greater communication and coordination between the various parties.

All resource movement was included in distribution. To begin, there was pickup at the point of acquisition such as manufacturing plant, warehouse, or recruiting station. The resources then normally moved to an intermediate station such as a storage depot or training site. Later, the resource moved to a site in the continental United States for use or for preparation for overseas shipment. This required the creation and maintenance of a host of continental US distribution facilities including transportation networks, warehouses, port facilities, cantonment areas, hospitals, and the like. For those resources moving overseas, there was a need to create and maintain overseas transportation, storage, and movement facilities that would finally include the construction, operation, and maintenance of ports, landing sites, airstrips, roads, living areas, and so on. Then at the end of the string in the United States or in the overseas location, there was the need to store and ultimately to move men, supplies, and equipment to the using forces (119:462).

The distribution systems established during the war were a continuation of existing prewar systems plus the massive array of systems established in many geographic locations for the war's needs.

All in all, distribution was done well and effectively, although for a variety of reasons, there were notable failures such as in the Philippine Islands in early 1942 and in the stopping of Patton's advance with his armored forces in Europe in 1944. Overall, though, distribution must be given a good report card for general effectiveness.

Requirements were not calculated by the distribution systems, although they did contribute to increased requirements. Had we been able to move everything immediately from its place of creation to its place of need, the requirements determination process would have computed far fewer resource needs. However, that was an impossibility, and we had to accept the increased requirements due to the function of the distribution systems. Additionally, there were some decisions made, which were well intended but turned out to be wasteful

For example, it was recognized that the receipt, breakdown, storage, and reshipment of supplies in overseas locations slowed the distribution to combat forces and added to costs. In 1943, the block-load concept came into being, first in the Central Pacific and later in other areas. The idea of block loading was to prepare and package in the United States all the materiel and supplies that would be needed by a thousand men for 20 days, at first, and 30 days later. For supporting the early phase of an operation, the block was composed of all types of supplies for that number of men for that number of days. For resupply, the block usually consisted of just one class of supply. The idea was to eliminate the sorting and movement of supplies at the overseas site, thus saving time and increasing combat and support capability. Further, the thought was that shipping could be reduced through the block-load system—a group of ships, each with block loads of one class of supply, could be moved in convoy to destination. The field unit could more effectively requisition by merely asking for a quantity of blocks, by class, rather than having to list separately the thousands of items involved (119:542).

The idea was good, but it led to waste and inefficiency. It was effective but costly. The net result was that soldiers ended up being overequipped. This loaded the soldier beyond need, and he shortly began to discard, thus waste, that which he felt unneeded. The discarded supplies, of course, were wasted, but even more wasteful was the use of transportation and distribution resources to get them to him (148). Also, the block concept was based on common needs, and common needs did not really exist. The computed needs of a soldier in Europe equated to 66.8 pounds of supplies per day, while in the Pacific it was 67.4 pounds (24:16). Making up that need were the following: (148).

•	Rations	7 lbs
•	Clothing/Supplies	6 lbs
•	Petroleum Items	33 lbs
•	Medical, Signal, Air, Transport	13 lbs
•	Ammunition	8 lbs

Bear in mind, these were commonly computed needs, which, in the prescribed block, could not take into account climate differences, nutrition differences, and the like. As might be expected, the result was a lot of supplies were distributed that were not required at the receiving site, and a lot of needs were not met by the common block load. Even so, the overall success was good. If the above figures are accepted, as they were in World War II, it is easy to begin to understand the vastness of the distribution problem. With 12 million men in

the Armed Forces, in the United States, and overseas, these figures would reflect a need for moving approximately 800 million pounds of supplies per day worldwide. Obviously, a tremendous job, which, just by virtue of its size, was bound to include some errors in judgment and result.

To assist in the distribution process, a range of supply depots was established. The Army Service Forces (the logistics arm) created key, regional, reserve, and filler depots. Key depots stored and issued scarce and limited-demand supplies such as arctic gear, chemical warfare clothing, and so forth. Regional depots, often called general depots, stored and issued to users all supplies except those in key depots and petroleum materiel. Reserve depots served as backup storage for the regional depots and made issues only to the regional depots but not to units. Filler depots were located near ports of embarkation and controlled the flow of supplies to the port thus trying to avoid flooding the port at any one time (148). The Air Service Command, functioning for the Army Air Forces, had a similar arrangement of depots using different titles. The Navy used a like structure but tailored to its peculiar needs. Petroleum products had special handling devised for their peculiar care and attention.

Naval Service Force, Pacific Fleet

The Service Force, Pacific Fleet, was established 17 February 1942 in recognition of the tremendous problems that would be coming with all-out naval warfare in the wide reaches of the Pacific. The Service Force was largely responsible for the ultimate fleet successes in the war, and its use was extended to the postwar Navy.

The Service Force provided US forces the ability to operate at long distances from established bases. It permitted the fleet to shift rapidly from one objective to another. It provided the means for sustaining momentum once the battles began. The service personnel expanded the replenishment schemes underway to include—in addition to oil—ammunition, provisions, and other supplies.

New concepts for the rapid establishment of support bases were developed. Combat salvage capabilities were developed and enhanced. The support bases and support vessels went wherever the fleet needed them and provided floating bases including floating drydocks, replenishment ships, garbage barges, water, fuel, ammunition, mail, repair ships, and all the other needs of the fleet (113:23).

The Navy found distribution for its sea forces very difficult in the Pacific where most of its operations took place. The distances were great, and for a large part of the war, the Japanese offered air, surface, and undersea opposition to supply ships as well as to combat vessels. The naval forces were almost totally dependent on petroleum supplies, of course, and these constituted a major part of the Navy's distribution concerns. Refueling had to be done at sea for task forces in operational employment. In the older, more routine, method of refueling, the ships would be almost drifting, which made them juicy targets. So the Navy set up roving fuel task groups consisting of large tankers with destroyer escorts. These fuel task groups waited in designated sea sites, which were rectangular ocean areas of approximately 25 miles by 75 miles. They steamed slowly through these designated areas and were joined by the ships needing refueling. The ships were refueled as they steamed along through these refueling rectangles at a reasonable speed, maintaining control and maneuverability (225:300).

Additionally, the Navy found the Pacific war tough on its distribution systems because of the absence of ports and bases in most of the islands occupied by our defensive and attacking forces. These voids offered large-scale construction headaches because there was no infrastructure on the islands to support the engineers' efforts and the Seabees' construction. Everything, practically, had to be brought to the site from either the United States or Australia.

The Seabees were exceptionally talented and skillful. They, often in conjunction with the Army's Combat Engineers, did a magnificent job meeting Navy and Army requirements for ports, bases, airstrips, living facilities, and medical care facilities. However, it seemed as soon as they would get one island in decent construction condition the fast-moving war would demand they move on to face the same problems all over again at a new site. They had to work at a high pace to avoid losing naval capability due to absence of support bases and ports. The two principal construction agencies certainly earned all the accolades they received and probably merited a lot more. But combat commanders, shortsighted, frequently refused to give up combat troop space, in manpower authorizations or in transport ship troop spaces, for engineers or support troops. Therefore, conditions worsened rather than improved as the war grew, and combat resulted in expanded movement requirements.

To further assist them in keeping the fleets, task forces, and attacking units adequately supplied, the Navy created, manned, and organized mobile supply and support bases that served to minimally meet the needs until more permanent facilities were available. They created towed fuel barges in the Pacific that helped to move fuel supplies into new areas, helped to offload fuel supplies when tankers could not get close to shore, and provided slow but reliable tagalong fuel supplies for some kinds of convoy movements.

Repair ships were not new to the Navy, but the quantity and variations required by the Pacific war were. Repair ships of all configurations, from small to very large, became common and did yeoman work throughout the war. Their actions saved many ships that otherwise might have gone to salvage or might not have been available for future combat needs. Tenders, tugs, floating docks, drydocks, and so forth further assisted. Quite often, this mass of support would be anchored in protected lagoons, safe from enemy attack underwater or from the air, and, from that anchorage, would do their support work until called upon to move (225:300).

War in the Pacific was not well studied before Pearl Harbor. Admittedly, there had been some studies of island-hopping war, some exploratory work on the various island groups, and a large amount of study on naval fleet engagements. But the

idea of a full-scale war, all over the extremely large Pacific area, was not studied. This war was a new experience and was not well planned or organized.

As earlier mentioned, there was no overall command structure, little or no joint activity, and not much interservice (and inter-Allies) coordination—particularly at command levels. In the units, though, there was often a high degree of cooperation between Army, Navy, Air Force, Marines, and Allies.

Distribution for all Services and all Allies predominantly moved by ship, not only from US ports but also between points in the theaters of the Pacific. Extremely long distances were involved. There was, for example, a 7,000-mile sealane from San Francisco to Brisbane, Australia—6,000 miles from San Francisco to New Caledonia. This required massive shipping resources because the distance was so great and the offloading so slow.

As indicated above, there were usually no ports or bases to ease the offloading problem or to handle large quantities of bulk storage for the various classes of supplies. The primitive ports were horribly slow, as is indicated by the conditions during 1 month early in 1944 at Milne Bay, New Guinea, when 140 ships were always waiting offload. At New Caledonia, critical supplies often sat in holds of ships in the harbor because they could not be offloaded. Sometimes the ship containing critical supplies would be moved to a pier, the critical supplies located and offloaded, and the rest retained in the hold while the ship left the pier to resume its position in the queue. Yes, it was wasteful and was never really overcome as the war moved closer and closer to Japan (225:300).

Petroleum

Petroleum products presented large problems throughout the war as they became logistics demands of unprecedented size. This was, as mentioned early in this history, a war of mechanized mass. Vehicles of some sort were available everywhere, and in many instances, every man seemed to have some form of transportation at his disposal. Almost all of this transportation demanded petroleum products for continued use, and approximately 50 percent of the shipping to overseas support was for petroleum products.

During the growth of technology in the 20th century, petroleum had become vitally important to the American economy and its ability to produce. Likewise, it had become a principal resource of the military. Combat capability often depended on one form of fuel or another. Patton's advance in Europe in 1944 was halted and is a prime example of tactical failure caused by the inability of the logistics system to provide timely and sufficient petroleum support. There was sufficient fuel on the European Continent, back near the beaches and ports of France, but it could not be moved forward fast enough and in enough quantity to permit Patton's tank forces to continue their rapid thrust into Germany. The war and the world might have been greatly different had there been sufficient planning, coordination, and preparation for this fast armored run against the enemy. Tactics, though, outran logistics and failed to coordinate with logistics and suffered for it.

As much as American industrial and military capability came to depend on petroleum, as important as it became, the military in 1940-1941 had no POL organization and practically no qualified petroleum people. Almost no records were maintained on petroleum use except for the records maintained for fleet ships by the Navy. The petroleum industry, strangely, was also not prepared for the massive needs of the war. No plans existed for expanding refinery capacity, creating new source fields or constructing new pipelines. During the war, the industry had to accommodate to vast needs for a wide range of products, in addition to a wide range of packaging and significant problems of storage. Distribution was a nightmare for most of the war.

For example, ground-use gasoline for vehicles and other purposes was required in bulk quantities in 55-gallon drums and in 5-gallon jerry cans. Aviation gasoline was required in bulk in 55-gallon drums. Diesel fuel was required in bulk in 55-gallon drums and in 5-gallon cans. Kerosene was usually required only in 55-gallon drums, but engine oil was needed in 1-quart cans, 1-gallon cans, and 5-gallon cans. Greases were needed in containers of 1/2, 1, 2, 5, and 20 pounds. This created not only outlandish production and packaging problems but also equally horrendous storage, issue, and use problems.

Petroleum was and is the lifeblood of modern war. As mentioned, more than half the tonnage of supplies shipped overseas in World War II was petroleum products. In fact, there were more than 400 specific and identifiable petroleum products in the inventory (36:122). Petroleum products did more than merely power ships, aircraft, or vehicles. They also provided power for:

- Heat, lighting and refrigeration.
- The repair of big and little war materiel.
- Pumping systems for fuel and water.
- Sterilizing systems.
- Evaporation and distilling systems for necessary industrial and human water uses.

Additionally, petroleum furnished the base for producing toluene for explosives, napalm for aircraft bombs and flame throwers, asphalt for roads and airfields, and chemicals for making smoke at sea or on land (36).

The Navy, of course, had major problems because the ships of the fleet were totally dependent on a continuing supply of petroleum products. Without the POL, they were, in effect, dead in the water and incapable of combat. The ships ran on oil and required it in vast quantities all over the world simultaneously. Additionally, aviation gas was a problem because it too was required in vast quantities and required separate storage and care on many ships and in many shore installations. The result, without considering the needs of the other Services or the Allies, was a massive procurement, supply and distribution problem (37).

Getting POL supplies to all needs worldwide demanded painstaking and detailed coordination with and cooperation from many agencies. The agencies involved included the petroleum industry, Army Service Forces, USN Bureau of

Supplies and Accounts, the Army and Navy Petroleum Board, the State Department, each of the Allied countries, and others. It was made more severe when the Navy acquired the responsibility for worldwide POL mass supply for US forces. That it worked so well through World War II is clear evidence of the dedicated efforts of many highly competent people.

Try as they might, the Navy was not able to be successful in all POL supply efforts. Generally, we seemed to have plenty of POL worldwide, but spot shortages of POL products were often very serious problems. The Navy acted to increase the quantities of tankers serving the world and succeeded, but still those spot shortages happened. For example, the Atlantic Naval Service Force increased its tankers from 15 in mid-1942 to 34 in early 1943, plus employing a great many more from the merchant fleets of many countries. Each of them usually carried 100,000 barrels or more of POL plus quantities of food and other compact cargoes. Even so, the shortage of high-octane gasoline caused the curtailment of US motor torpedo boat operations at Salerno until a tanker arrived. When she arrived, she had been bled by other forces and had only about one-third her normal high-octane gasoline cargo aboard, not enough to refuel the force one time (36).

In the Pacific, the consumption of POL was even more huge. The distances involved, as we have related, meant continuing additional needs for POL for the fleets as well as the shore forces of all Services and Allies. At Tulagi, Solomon Islands, alone, early in 1943, aircraft were using 1,000 gallons of aviation gasoline daily and the PT boats about 7,000 gallons daily. In late 1943, in the same general area, aircraft were using 10,000 gallons per day and PT boats 5,000 gallons per day—and this had become somewhat a back area of the war. For the afloat needs, the requirement in the first half of 1943 was 1.3 million barrels of POL a month and rapidly growing (37:50).

Very often, as in the island war of the Pacific, Army, Navy, and Marine Corps aircraft operated from minimally prepared strips and bases. No real POL dispensing capabilities existed, and fuel had to be pumped, usually by hand, into the aircraft from 55-gallon drums. Literally, hundreds of thousands of man-hours of service and support troops' time were spent in this backbreaking and very dull job. Yet it had to be done, and it was continually done until some form of powered bulk supply dispensing was installed. Until that happened, though, the fuel was hand-pumped, and readying a sortie was slow and difficult. In addition, many men were physically injured by rolling or falling drums and by trying to lift far more weight than they safely could. The motivation of the troops to get the aircraft ready for action against the Japanese was the redeeming factor, but it in no way lessened the real problem of distribution.

The small container storage of petroleum products led to other problems. As long as possible, the small storage containers were not used because the larger containers helped get the job done faster. But the longer the smaller container and sometimes, later, the bulk storage was held, the less satisfactory the POL products became. Gasoline gummed, algae grew in kerosene, and fungus flourished in diesel fuel. These foreign elements clogged filters and blocked fuel valves and carburetor jets causing engine power losses, sometimes loss of aircraft, and sometimes failure of support transportation.

One approach to resolution of this distribution problem was to ship in bulk and package in smaller containers at the receiving site. In more than 20 locations in Europe and the Pacific, we set up capability for manufacturing drums and smaller cans into which the bulk POL could be moved for local distribution. This led to petroleum depots, petroleum storage areas, and special petroleum transportation units, which ultimately helped to meet the problem. But we never did really solve the overall problem of petroleum distribution (225, 148, 119).

Petroleum pipelines were constructed for product distribution in the United States, under the English Channel following D-day, and alongside the Stilwell [General Joseph] Road in Burma, for example. In the United States, the *Big Inch* pipeline, 24 inches in diameter, was built from Texas to New Jersey. The *Little Big Inch*, a companion of 20-inch diameter, carried more than 200,000 barrels of aviation gasoline a day. These, of course, were of great help, finally, but for the most part, those pipelines in overseas areas came too late to be as beneficial as envisioned by the planners. Distribution of POL, as with all other resources, was a true logistics challenge and remains so.

Combat engineers, in the form of engineer petroleum distribution companies, came ashore in France immediately following the initial D-day landings. Their job—in addition to essential mine clearance, bridging, and road work—was to create a pipeline supporting Allied forces n Europe. Obviously, the German forces resisted this effort, and the engineers were targets of snipers and artillery. Nevertheless, they continued to accomplish their most difficult task.

The first companies were severely handicapped because the materials needed were strewn all over the landing areas and some, in fact, never showed up at all. The D-day landings had been very rough, and many supply vehicles, landing boats of various kinds, amphibious trucks (DUKWs), and larger ships were sunk. Others were damaged and unable to function. Many were lost in subsequent tidal action because they were unable to protect themselves with controlled movements. Problems were created because the planning called for the first POL pipeline to be completed in the first 10 days ashore. The pressure of constant combat activity, German air raids and artillery fire, and the push to build the line made for a hectic and demanding life.

The pipeline under the ocean (PLUTO) was supposed to be constructed from the Isle of Wight to the French shore. However, since the capture of Cherbourg was essential but not accomplished, the early PLUTO effort was not completed in time to help.

Original efforts went to establishing the necessary submarine pipelines that would permit offloading POL products from tankers offshore to be carried under water, up the shore to hastily erected bolted steel tanks on shore. For example, there were five initial tanks, each holding 10,000 barrels. One tank held gasoline for the Army, three tanks held diesel fuel for the Navy, and the fifth tank held gasoline for the Navy. The Army's fuel was then carried through 4-inch lines through in-shore pump stations to hastily erected

servicing tank farms. For example, the planned tank farm at Mount Cauvin was for 30,000 barrels of ground-use gasoline. The tanks were located above the vehicle service areas so the fuel could be gravity fed to tank truck dispensers and to a pump station that was further connected through 4-inch lines to the British pipelines being constructed.

After Cherbourg was captured, the American pipeline system—carrying ground-use gasoline, aviation gasoline, and diesel fuel—was rapidly expanded. The major system consisted of three pipelines: two were for 80-octane ground-use gasoline, and one was for 100-octane aviation gasoline. The ground-use lines received priority because the demand for vehicle fuel was much greater than the demand for aviation gas. By September 1944, the pipeline system had more than 100 miles of length. Its larger elements consisted of three parallel product pipelines.

Above ground, the lines were connected and sealed with victaulic couplings. At highway crossings and rail crossings, connections were welded so they could be placed underground. Underwater connections at rivers and streams were generally welded as well. The pipes were originally laid alongside road beds in the shoulder areas because that permitted the most rapid laying of the line. That procedure soon proved faulty because careless GI truck drivers and vehicle accidents nearly always resulted in damage to the lines, with resultant leakage and increased maintenance demands. It was soon found more rational to lay the lines in the fields roughly paralleling the lines of communication yet away from the traffic. While this preserved the pipeline, it was slower because minefields had to be cleared and access paths developed in rough territory.

A great many troubles existed with the pipelines. Some connections leaked badly because of hasty construction efforts. Some openings in lines were invitations to small animals, which died and plugged lines and valves. GIs often stuck C-ration cans in pipeline holes with similar plug-up results. Black market entrepreneurs punched holes in the lines and drained fuel so they could then sell it at a high price on the market. Obviously, if black market operators could get to the lines so could saboteurs.

These problems were generally overcome, and the system functioned well. The Army engineers have received very little publicity and gratitude for their strong and effective pipeline work in Europe. Yet their work enabled Allied mechanized forces to overcome German forces and win the war in Europe.

Mail, Music, Films, and Books

The distribution function of logistics must move a great many different things. In World War II, a major morale factor for the troops serving overseas, in particular, was preserving some sense of relationship to home. This was very important to the morale and the welfare of the personnel. The Services did a fine job, overall, providing means for the men to keep their spirits high and their dedication strong. Nevertheless, the two major gripes of the troops overseas were mail and food, closely followed by other connections to home. Because of this, the Services concentrated on providing food, mail, books, music, and films wherever the forces went. We will discuss food later in this chapter, but now we need to consider the distribution problems of mail, books, films, and music.

Mail

When soldiers, sailors, marines, or coast guardsmen are serving their country in wartime on foreign soil, news from home becomes very important. In World War II, mail served as the principal news from home. True, there was radio, and the forces in most placed outside the United States did have some Armed Forces Radio local area broadcasting. But that could not—and did not—replace letters from family, sweethearts, and friends. So mail became the number one point of concern for the far off, often lonely, military person.

Yet mail represented a tremendously heavy drain on available shipping and air transport, particularly in the early days of the war before our production efforts began to pay off with great quantities of ships and aircraft. The available cargo capacity had to first be dedicated to military cargo with mail normally taking second priority. Mail had higher priority than some personnel travel, higher priority than some forms of cargo and so forth, but it was still a major weight and bulk problem for the limited capacity.

In the Atlantic Fleet, at first, mail, both official and personal, was not delivered regularly. In the South Atlantic, Pan-American Airways aircraft delivered some mail four times a week. The Brazilian postal system then delivered that mail to the nearest US Navy office. Further distribution was made in whatever way it could be gotten to the destination. Delays, often very long, were inevitable. The process was slow, aggravating and inefficient. Some Army Air Forces bomber aircraft en route to North Africa also delivered mailbags as they stopped for refueling before the transatlantic flight. Again, the drop was only at Natal, and the mail then had to find its way to its destination somehow. In October 1942, the Navy began a regular Naval Air Transport System (NATS) schedule of mail deliveries for official and personal mail. Conditions began to be better for this important commodity (36:128).

The Army and Navy worked jointly to develop a worldwide system of mail to the troops that would not require massive transport capacity yet would be fast and private. The Eastman Kodak Company had developed a microfilm mail system for the British. It was in use from mid-1941, moving official and personal mail between England and Egypt. Mail leaving at each end was microfilmed. On receipt at the other end, it was enlarged, printed, and delivered through the usual mail channels. The system worked satisfactorily. The US system borrowed heavily from the one in use by the British, and in middle 1942, the new system began operation. It came to be called *V ...- Mil* and was a tremendous help getting those morale-important items to and from the troops.

The US Post Office delivered the mail within the United States to and from the Army and Navy post offices (APOs and FPOs). At those places, the mail was opened and microfilmed by Eastman Kodak contract personnel. The Army Signal Corps

and Navy postal personnel did the microfilming overseas. The same units that microfilmed outgoing mail also magnified and printed the incoming mail for delivery. Thus, the GI, sailor, marine, or the folks at home received a paper piece of mail and not a piece of film.

A V…-Mail letter was written on special forms that were 8-1/2 x 11 inches in size. The white paper had limiting borders printed on it and offered enough clear space for a carefully written letter of about 600 to 700 words. The form, when ready, was folded, sealed, and stamped with the then necessary 3-cent stamp. Obviously, no enclosures could be sent since they would not be able to be reduced by the single-page microfilm. However, a lipstick kiss or a sketch (anything written or drawn within the borders) was okay and would reproduce. Color changes in writing or drawing would not be reproduced in color so that a lipstick kiss, for example, would not be red but in varying degrees of black on the reproduced copy. The reproduced and delivered letter was similar in appearance to a film positive and was somewhat smaller than the original form. In general, the reproduced size was about 4x5 inches; nevertheless, the writing was legible given that it was legible on the original paper.

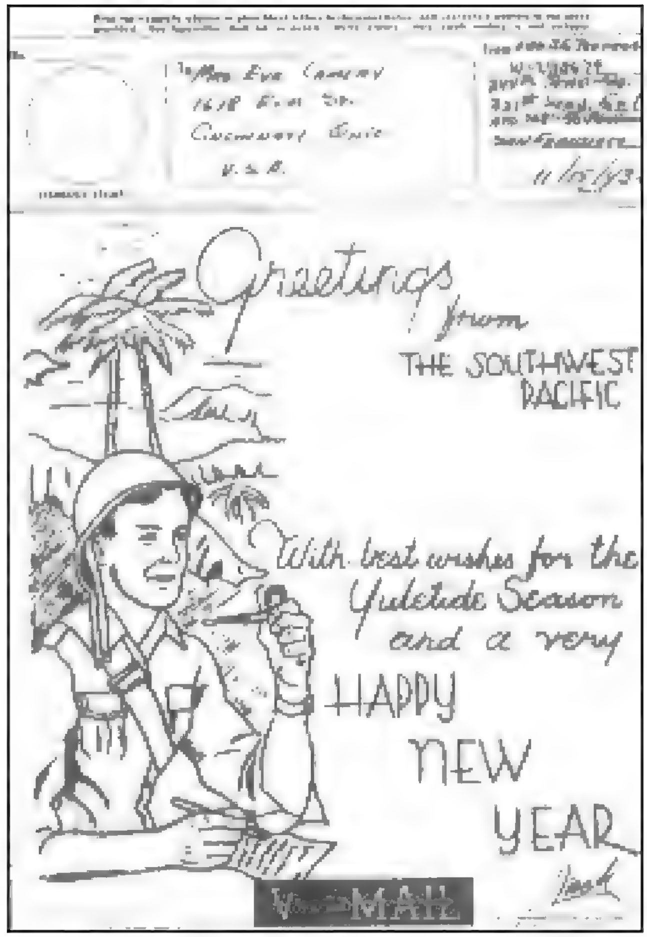
The mail was shipped, by air, in microfilm reels. One reel of 100 feet of 16-millimeter film would contain about 1,500 or more letters. That reel would weigh only a few ounces but would be in place of pounds. Someone estimated that 25 pounds of V…-Mail film reels replaced 2,000 pounds of paper letters. Ultimately, the system processed millions of V…-Mail letters a month to military persons overseas and from overseas back to the United States each month. The highest volume was in the spring of 1944 when the system moved more than 64 million letters. The Army postal system, alone, stated that in August 1945 the average GI wrote six letters a week and, in the single fiscal year of 1944, the APO system handled 3,611,920,000 letters.

File reels were maintained until the system had assurance of delivery. That way, if an aircraft went down at sea or was lost in a crash, for example, the reels shipped in its cargo would be copied and resent on the next aircraft. People used the V…-Mail with no hesitation. Censoring, when needed, was done with white cover-up strips that left white spaces in the reproduced copy. Christmas, birthday, anniversary, valentine, and other special occasion drawings were made by clever persons on both ends of the mail to be used in lieu of cards so much a part of the American lifestyle.

V…-Mail (did you notice the Morse code for *V* in the system title?) ended with the war's end and has not been used since. It served the country with distinction and was a functional logistics operation in which we may all have pride. Military personnel and their correspondents were certainly grateful for this logistics innovation, which gained them much better and more efficient mail service worldwide (170).

Films

By the time of the war, the movie had become a significant part of the life of most Americans. During the Depression, movies had served as a primary means of escape from the



harshness of life for millions. So it was not unexpected that movies would be important to the soldier, sailor, or marine wherever he—and later she—might be located. Surveys of the troops showed movies ranked next to good food and mail service and their primary concerns about their wartime lives.

The distribution of films became a science of its own during the war. Special offices were established to control films and arrange their distribution in specific areas of the world. Records were required to help avoid sending the same films repeatedly to the same units. In other words, a mini-supply and distribution system was required. The Navy established fleet motion picture exchanges on support vessels. For example, the destroyer tender *USS Prairie* was one such center. Later, the exchanges were extended to other vessels and many shore locations. The Army, meanwhile, was doing the same in its efforts to provide good movies to troops worldwide.

The need was for trained personnel who could care for the films, repair them when necessary, and correct any faults reported by users. The need for attentive service was great because the films received hard use in the diverse climates and environments of the war. Further, many of the people who operated the projection equipment were not well trained and easily and quickly damaged the films. When a film tore or skipped while in projection, the howls of the viewers could probably be heard all the way back to the United States. The

same sort of complaining was very evident when the sound track became scratched or intermittently lost.

Films had high priority in the distribution channels. They could often *bump* a passenger from air transport as the Services worked to keep the overseas morale high. The film exchanges and control offices tried very hard to maintain some form of control over the films. But film trading became a major art. As the word spread about a particular film, *one you must see*, the scroungers were sent out from a unit, and one desirable film was swapped for another. The film soon was *lost* in the process but was still of continuing use and great value. Any film was valuable, though, whether or not it was *good*, and it was very rare for a film not to be shown hundreds of times regardless of quality.

Films were shown wherever they could be seen. The Navy vessels showed them on deck when lights were allowed, or the wardrooms and messes were used. Aircraft carriers showed them on hangar decks. Army and Marine units showed them in tents, in mess halls, or outdoors. In the Pacific Islands, the movies were outdoors with seating provided by fallen coconut trees. The nightly movies, ashore or afloat, were heavily attended and prime morale factors for the men and women serving their country.

Books

The popularity of paperback books today probably stems from their widespread use in the military services during the war. Hard cover books were quickly recognized as too bulky and heavy for continued distribution worldwide. The soft cover, paperback book with its smaller pages and greatly reduced weight became the library supply.

The average American military person was a heavy reader during the war. The books were probably akin to the movies in that they offered release from boredom and easing of the pains of separation from family and home. Ground combat troops often had a book or two in their pockets or packs for recreational use when combat permitted. Mechanics often had them in their toolboxes. Troops on transports heading overseas had several in their baggage. Again, like the films, trading and swapping became a regular activity, and the books flowed through the informal channels until they could no longer be held together or read.

The Services provided libraries of some sort, usually in each shore unit or on each vessel. The *librarian* was a member of the unit assigned the extra duty or a member who volunteered to do it. The books were provided through the morale services of the Army and the Navy. Shipments of books did not receive the priority of mail or films, so when they arrived, a rush of collection and trading began. A great many additional books were provided by the very effective services of the American Red Cross with particular emphasis given to distribution to hospitals and recreational areas. In all, millions of these small books were distributed all over the world, and the service people left many when the war ended and they came home.

Music

Music has always been a popular part of military life. It was even more popular during the war because the radio and record player had become so much a part of American life in the 1920s and 1930s. Troops in the United States, of course, had little problem hearing the music of their choice because they had access to the local radio stations and to whatever records were available in stores or libraries. Overseas was another story—particularly in areas that had little of the niceties of civilization, such as radio stations.

So the Services created the Armed Forces Radio Service, which attempted to provide news, music, and official information through radio service for the troops wherever they might be. Records were important to the stations and the personnel in units that possessed record players. To meet this need, the Services developed the *V-Disc,* a short-life record made of noncritical material. The V-Discs were recordings of civilian and military musical groups and personages destined solely for military use. The master recording for the V-Disc was retained for reuse until the war ended. At that time, the V-Disc master recordings were destroyed to stimulate the return of the civilian recording industry. Very few of the V-Discs exist today so they are highly sought collector's items. But they served their purpose in World War II, and millions of military personnel had moments of pleasure from them.

It might be worth mentioning that while the Armed Forces Radio Service generally did a fine job, there was some dissatisfaction with what seemed to be a limited music collection. Thus in some areas, the Armed Forces Radio stations were not too popular because they seemed able to merely repeat what had just recently been heard. In the Pacific, for example, we solved the problem by concentrating on *Tokyo Rose* at night when we could pick her up on our small radios. In some manner, she seemed always to have the latest recordings from the United States, and she programmed a much wider selection of music. In addition, it was entertaining to listen to her propaganda that came between records.

Finance

The men and women of the military forces worldwide deserved to be paid on time whether in combat or in the United States. Historically, troops had been paid in cash. Generally, this required an officer of the unit to claim the unit payroll at some central finance office, sign responsibility for it, and under armed guard, bring the large sum of cash to the unit. The cash was then counted out, according to a pay list, and put aside for each person in the unit. Any error required the entire payroll to be recomputed and recounted by the unit pay officer, adding to the labor and time to accomplish the task.

The individual had to go through a military ritual saluting the paymaster, signing the pay list, and accepting the cash due. If an individual could not be paid because of some absence, the cash had to be returned to the central finance office with additional paperwork. In some units, pay call was tied to some form of personnel inspection, adding to the time and effort required.

This may, on the surface, seem to be no major problem. However, the transportation of cash was a logistics problem. It had to have total and complete security at all times en route and at every stop. This required special transportation controls, secrecy of movement, armed guards, safes, and so forth. Further, cash can be very heavy, and many cash payments to a theater of operations exceeded 100,000 pounds of sensitive cargo—a major logistics problem.

Yet it had to be done. The troops deserved to be paid. In the United States, there was less of a problem for everyone because the system had been in use for years and needed only expansion to accommodate the growth of the wartime forces. Overseas, all was new and different, and the system to handle the pay had to be constructed. It was important to morale and had to be done. Further, in many overseas locations, the pay due had to be computed in a local currency and the payment made in that currency. In some areas, a form of scrip or *play money* was used. This and local currency met local needs, of course, but created further problems for the finance and pay people. Often, the rate of exchange and value of the local currency was not understood or accepted. Then, too, there were the computations required and the increased possibility of error.

Further problems were encountered in some combat units because the men did not need or want the cash. They often refused to come to the pay officer, and their pay accounts built up over time, adding to the accounting problems. Bear in mind, too, this was before the days of the computerized pay processes. Everything was manually accomplished in the field and was one more element of morale logistics. It was, though, especially well done everywhere in the world, and the finance people in all Services earned the gratitude of millions of service people.

For these reasons, as well as for assured pay, personnel were encouraged to assign the bulk of their pay to allotments to wives or husbands, parents, children, or a financial institution. Many did this and accepted only a small part of their pay in cash. The allotment money would be delivered by check through the mail to the intended recipient shortly after the first of the month. Each allotment reduced the task of finance in the field and was a welcome and trusted method, although it did create another logistics system, which had to be managed and operated.

Transportation

While transportation is a major part of distribution, it has a significant mission more or less its own and warrants separate mention. In World War II, the world's transportation networks were strained to capacity by all the warring powers. Strategists recognized the vital importance of the transportation networks, and each side made a strong effort to wreak havoc and destruction on the enemy's rail, air, water, and highway capabilities. The Axis Powers and Japan were not successful in limiting their opponent's transportation even though they tried with great effort. In the early days of the war, they were very successful, particularly acting against ocean transport. Later, of course, the massive strength and quantities of Allied power eliminated the threats. The Allies did succeed in practically destroying the enemy's networks and effectively drove the enemies to defeat by that success. Certainly by war's end, it was recognized that transportation was the arterial system of modern civilization. Therefore, it became a basic consideration of strategy to destroy the opponent's transportation networks and a basic decision of tactics to protect one's own networks. A principal function of logistics had also become a concern for both strategy and tactics.

There was not much doubt the most economical means of transporting the vast quantities and sizes of World War II materiel was by water movement shore to shore. There was also not much question it was the slowest form of transport and vulnerable to the enemy's submarine, surface, and air attacks. However, for the most part, there was no alternative to water movement, considering the quantities, weights, and sizes of supplies and equipment to be moved. When it was practical, air transport was used for speed and sometimes for airdrop delivery directly to the combat or support troops. Ground transport was the prevailing means when roads and bridges permitted, and it was the principal means for movement of people and things in combat areas.

Ground Transportation

Ground transportation made this a war of mechanized mass. Vehicles of all sorts abounded and were the principal means of transport when the terrain permitted. Even when it did not, the troops made the terrain fit their needs by building roads, bridges, and other elements of ground transport infrastructure. The Corps of Engineers, Aviation Engineers, Combat Engineers, and the Seabees all labored mightily, often with indigenous help, to construct roads and bridges where none had ever existed before. They forded streams, filled in swamps, and did all kinds of miraculous things to make supply of the troops and support of the occupied territories, quickly and effectively.

Some of the lands were almost impossibilities for road and bridge construction. The Stilwell Road connecting Ledo, India, with Kunming, China, was through mountainous territory, raging rivers, and almost impenetrable jungle. Yet the troops and native persons succeeded in at last opening 1,000 miles of the road in January 1945. In the islands of the Pacific, similar miracles took place although not to the great distance of the Stilwell Road. But thousands of miles of roads were built on those islands that had never before even seen a vehicle, which provided a network of great capability for our military purposes. In North Africa, roads were built and existing roads improved. In southern Europe and throughout the Continent following D-day at Normandy, the existing road network was protected, improved, and retained for essential support of our actions and the occupied lands.

By 1941, the automobile had become the personal transport for American people. The train and the bus systems worked well and carried large numbers of people everywhere in the country. But it was the automobile every family wanted. The onset of war drastically affected this love affair in the

United States. Gasoline and tires were rationed. Highway speed was reduced to 35 miles per hour. Rubber was so essential to the war it could not be made available for car tires, so the national authorities arranged to use some synthetic rubber for rationed automobile tires. Road maintenance was limited to only that which retained the road; there was generally no improvement work and no extension work other than that needed for war production purposes.

The Jeep. Millions of words, including at least one book and several songs, have been written about the Jeep since its birth in the summer of 1940. It became a famous vehicle around the world and is mentioned in a majority of the histories.

The Jeep came to exist in response to a stated Army requirement for a small, highly reliable vehicle with rough terrain capability. This might well have stemmed from the developing sense that horses and mules, used throughout history for military transport, would no longer be appropriate in modern warfare. It was also a recognition that a reconnaissance vehicle, safer and more capable than the motorcycle, would be needed. At any rate, three companies (Bantam, Willys-Overland, and Ford) responded to the Army's stated need, and after some testing and evaluation, the Willys-Overland design was accepted. Bantam production facilities were too small to permit them to participate in the high-quantity production required, so the production contracts went to Willys and Ford, using the Willys design. Ultimately, the two companies produced about 650,000 of these marvelous machines for World War II. Each Jeep cost the government approximately $900 by mid-1945.

The vehicle was known officially as the *Truck, ¼ Ton, 4x4, GP*. This meant it was a general purpose (GP) truck with carrying capacity of approximately 500 pounds (1/4 ton) and four-wheel drive availability (4x4). The name *Jeep* just seemed to happen. No one knows for certain where the name originated. The test drivers for Willys stated they had always called it *Jeep* but had no idea why. Most historians seem to agree that the *Jeep* stemmed from the GI slang voicing of the *GP* in its official identification. Some others, though, attribute the name to a character that had for 3 or 4 years appeared in the very popular *Popeye* cartoon strip—a character named *Jeep*. Perhaps it was that identification, coupled with the voiced *GP,* that made the name. Whatever, the name became known around the world in all the countries, Allied and enemy.

Regardless of the origin of the name, the Jeep became the love of the soldier, sailor, and marine. This little vehicle and the military forces of the Allies came together with strong emotional ties. The Jeep was loved and praised by the lowliest private and the highest politician. Stalin thought it the key to victory. Britain's Queen Elizabeth (now Queen Mother) loved to ride in it. General Marshall thought the Jeep was America's greatest contribution to modern warfare. Ernie Pyle, the famous World War II correspondent, wrote glowingly about it and said in one column it was " faithful as a dog, as strong as a mule, and as agile as a goat." There probably was not a single person in the US military in World War II who was not somehow personally touched by the Jeep.

The Jeep was a versatile and useful vehicle that was also fun to drive despite its inherently dangerous narrow tread and unbalanced state. It displaced the animal for military transport and became the sweetheart of millions, probably because it was so useful yet so much fun to handle. It was exceptionally reliable and mechanically straightforward. It rarely broke down beyond the repair capabilities of the driver. Most faults were quickly corrected and most repairs could be done onsite by almost anyone—there was little need for highly skilled maintenance support. Its 60-horsepower engine was durable and sufficiently powerful to do what was asked of it. Its transmission and 4-wheel drive also claimed high reliability and minimal repair requirements. The Jeep with no load, on a highway, at 50 miles per hour got about 14 miles to the gallon of gasoline.

Seating in the Jeep was tough. The seats were uncushioned, and the vehicle was hard sprung. It rode like a heavy truck bouncing and jouncing the occupants. However, it rode about the same whether on surfaced highway, muddy terrain, or rocky stream bed so the operator was rarely surprised except for the tendency to roll over under certain angle conditions. The standard Jeep came with a collapsible canvas top. Those destined for use where winter weather was a problem also had

American Jeep towing antitank gun. (Courtesy of National Archives)

combination canvas and isinglass side curtains to enclose the seats and provide minimal weather protection. Heaters were not standard, but people managed to equip their Jeeps with some form of heat when winter made that demand (69, 73, 131).

There were uncounted uses for the Jeep. Everyone wanted one, and many claimed one for personal transport and kept it as long as they could. The Jeep could easily carry four people, and five or more could be carried if seating was demanded. In addition, the Jeep was frequently used for other purposes including the following:

- Machinegun platform with the gun mounted on a swivel where the backseat would normally be.
- As a true truck with a locally manufactured and installed flatbed behind the driver seat.
- Medical evacuation with stretchers across the beam fore and aft or in layers on racks on the back.
- Small aircraft towing tractor.
- Radio command post.
- With a front blade, as a minibulldozer.
- With homemade permanent top and sides as a sedan or van.

The Jeep will always be remembered by the World War II veterans as the most effective and useful vehicle of its time. We owe it a lot for its logistics support accomplishments.

The Floating Truck. Not many people remember the *floating truck* of World War II. It was initially rejected by military specialists, but it proved to have great capability. Frequently, it met a need nothing else of the time could meet. As a result, it became a much used vehicle.

The floating truck was an amphibious vehicle known by the initials DUKW, usually pronounced *Duck.* The DUKW identification stemmed from the manufacturer's coding. General Motors developed and produced the vehicle, and in GM, *D* stood for 1942; *U* for utility; *K* for front-wheel drive; and *W* for two driving axles in the rear.

The requirement for the DUKW came from Army tacticians and logisticians who recognized the inadequacies of available landing equipment in the 1942 North African invasion. The small landing craft that had to be used were often unable to get very close to water's edge. They were not designed for this form of landing support. Therefore, they had to be offloaded by manpower often shoulder deep in surf. This exposed the craft and the people to enemy fire, which could be made very accurate since the targets were relatively immobile. Further, the craft often stuck in the soft or sandy bottom and were unable to free themselves for reuse. Again, they became handy targets and wasted assets. The loss of small craft was in the neighborhood of 30 percent of the available fleet.

About a year before this, the US Army Corps of Engineers had asked for help in developing an amphibious Jeep. The small amphibian was developed, but it was not very useful for assault landings. The effort that went into its development helped GM develop the DUKW, which was in reality a hull built around the standard Army 6x6 truck. That truck was rated at 2-1/2-ton capacity, although it often carried considerably more during the war. The vehicle could have all six wheels powered, which caused the classification *6x6.*

The DUKW was a 6x6 with a welded steel hull built so the wheels were outside and able to use the ground and roadways. The 31-foot hull had a propeller that powered the vehicle when in the water. When in the water, it was steerable with a rudder that was directed by the vehicle steering gear. A bilge pump maintained a reasonably dry interior while in the water. More than 20,000 were built for the Allied forces in World War II. The tires could be remotely inflated or deflated by the operator. The tires could be at low pressure when necessary for traction on the beach or at high pressure when on solid ground or on a roadway. On the roadway, the truck could travel about 50 miles per hour.

Once the operators were trained in handling of the DUKW, it became a valuable unit of equipment, particularly for amphibious or for resupply from offshore ships. Further, some DUKWs were equipped with rocket-firing structure and could be used as close-in fire support vehicles. Almost all of those designated for use in assaults were equipped with some form of rapid fire weapon. Overall, they proved their worth in assault actions and in resupply actions on the beaches.

The DUKW could maneuver out to a cargo ship, receive a load, maneuver its way to the beach, power itself up on the beach, and drive to wherever necessary for offloading. Thus the stationary targets of earlier times were avoided, and fewer people were exposed to potential enemy fire as they served as stevedores and bulk carriers. Ashore, the DUKW, functioning as a truck, could quickly move great weights and quantities of materiel to needed locations, thus lessening the need for manpower.

Rail Transportation. Wartime rail transportation in the United States was amazingly successful and efficient overall. Troops who rode converted cattle cars used as troop trains would probably not agree with that statement, but the railroad industry cooperated and did all it could to help win the war. Private ownership continued under general control of the Office of Defense Transportation (ODT). The ODT, formed in 1941, kept its efforts primarily to making policy and coordinating efforts. The railroad industry had fewer engines and cars than it had in World War I, yet it moved approximately 80 percent more ton-miles of cargo and 85 percent more passenger miles than in World War I and did it with reducing costs. At the end of the war in August 1945, freight rates were actually lower than in January 1942.

Rail shipping was closely coordinated with port capacity and handling ability. The Transportation Control Committee was established with membership from the War and Navy Departments, Office of Defense Transportation, War Shipping Administration, and British Ministry of War Transport. The committee used information about shipping needs, availability

of cargo space, ports, and the like to issue block releases. The block releases resulted in unit permits for the shipping of government and lend-lease freight, except Navy cargo, which was controlled separately by the Navy Department. Commercial freight was controlled by the Association of American Railroads. The system worked well but did cause some disagreements when service priorities could not be observed. Particular attention was paid to oil tank cars to ensure they moved with little delay or standing (159:262-5).

Maintenance of the rail infrastructure received high priority because the system was so vital to the war. As a result, the war left the rail system with less troubles than most other elements of the national transportation structure. Railroads in Europe, North Africa, the Middle East, and India were maintained and protected as we obtained their use. Some new liens were installed where combat and assault actions had destroyed existing capability. In the Pacific, not much was done to construct rail lines of any significance in the island chain leading to Japan except for resurrection of the lines in the Philippines.

Ocean Transportation

Sea transportation was the key to our continued success in combat around the world. It did not start out that way. The Depression and lower wages in foreign yards put the US shipbuilding industry in very poor condition just prior to the war. Germany's invasion of Poland and Great Britain's entry into the war caused Britain to place orders with US yards for 60 ships in 1939. These orders rejuvenated the fading industry, and by war's end, it had built more than 5,300 oceangoing vessels for our Allies and us (50).

The Liberty Ship. A major contributor to the victory of the Allied nations in World War II was the Liberty ship and its *daughter*, the Victory ship. Altogether, about 4,700 of these vessels were built, mostly in US shipyards. Some were also built in Canada, for use by American crews and all our Allies.

The American shipbuilding industry was not in good shape when war began in Europe in 1939. This was principally due to the isolationist swing in the United States and the Great Depression that began in the fall of 1929. Yet when war began, England and France needed help, and shipping was the immediate means for moving logistics support materiel to them or by them. But we had very little shipyard capacity, and our merchant fleet was small.

After a lot of soul-searching, President Roosevelt authorized shipyard action, and we began building the Liberty ships from a modification of a British design circa 1885. We changed the British design to permit use of fuel oil in lieu of coal and to provide crew quarters in an enlarged deckhouse rather than in the forecastle. The powerplant was triple expansion steam because we did not have the industrial capability to build the reduction gearing necessary for high-speed turbines. Most of that gearing was of German manufacture and, of course, not available to us then. We later built the machinery and capacity for US production of the gearing in 1943 and improved the Liberty's performance.

The Liberty was 441 feet long with a 57-foot beam and 37-foot draft. It displaced 14,000 tons and could carry about 9,200 tons of cargo with a full fuel load. Most of the hulls manufactured in the United States were welded plate. Later, some ships had large riveted bands around the hull to ease the strains left from the welding heat and stresses. The crew usually consisted of 44 officers and men, and often there was an additional 20-man US Navy gun crew. Cargo-handling equipment was relatively simple and very reliable, to permit worldwide use in any port and minimum major maintenance requirements.

The Liberty ships were manufactured in about 60 shipyards (including some of the Great Lakes and interior rivers). Eighteen of the yards were constructed just for the Liberty ship effort. Pieces were manufactured by more than 500 plants and facilities in 32 states. Finished pieces were directed to the yard by a central control agency, and the system worked exceptionally well. The first launch, the *SS Patrick Henry*, was in September 1941, and in total, more than 2,700 were constructed. The time of construction was ultimately reduced to about 3-1/2 months from keel to delivery.

The Liberty was a good ship but slow. It could steam about 10 or 11 knots and was vulnerable to submarine attack. As a result, it was known in the North Atlantic by German U-boats (submarines) as *Kaiser's Creeping Coffins*—the Kaiser coming from the principal US manufacturer, Henry J. Kaiser.

It was a very reliable ship that gave great, faithful service in all the ocean areas of the world. It was a war weapon that matched its time. The Allies and we had to man ships with inexperienced crews because of the massive growth of shipping needs for the war effort. The Liberty was kind to the very green and often raw recruit crews. It handled rather easily, rode the seas well, and took the punishment of the crews as they made mistakes while gaining experience and capability.

It was also very versatile. It was originally designed for cargo but soon became almost everything in addition. For example, Liberty ships became troop/cargo transports and, in some instances, oil tankers. Some handled only one form of cargo, such as coal, but most were used for whatever the war demanded. Some were cut in half to allow insertion of a 60- to 80-foot expansion to increase cargo capacity. Amazingly, that change increased its speed by a couple of knots because of altered wave forms around the hull. (58, 204).

The Liberty ships continued in use around the world after World War II. Many were given to emerging countries and to reconstruction programs. They continued in use through the early 1960s. The United States put a number in its National Reserve Fleet storage starting in 1946, but they were gradually withdrawn, a number of them for service in the Korean War.

The Victory ship was the Liberty's *daughter*. It was built around a modified Liberty hull, lengthened 20 feet, and provided with steam turbine power. This gave the Victory about a 17-knot cruising speed. It began to replace the Liberty, but the war ended before it fully displaced its parent. About 2,000 Victory ships were constructed between first launch in 1943

Freighters—Liberty ships. (Courtesy of National Archives)

and the end of 1945. The fate of the Victory is similar to the fate of the Liberty, and there probably are none left in service today (58, 204)

The design features of these ships were somewhat dictated by immediacy rather than performance. But they did their jobs extremely well and became very effective, very critical sealift for millions of tons of essential cargo and millions of troops worldwide.

Special Watercraft. Additionally, there was need to construct the ships of the fleets. Thousands of naval war and support vessels were produced. These ships made possible the great naval victories and the amphibious operations of the Pacific, North Africa, Italy, and France.

Among the special craft constructed were such classics as:

- Landing Ship—Tank (LST).
- Landing Ship—Dock (LSD).
- Landing Craft—Tank (LCT)
- Landing Craft—Personnel (LCP).
- Landing Craft—Assault (LCA).
- Landing Craft—Infantry (LCI).
- Attack Transport—(APA).
- Attack Cargo—(AKA).

There were others, but these will illustrate the range of specialized sea transport developed mostly for logistics purposes supporting combat operations. The LST could carry 13 to 20 heavy tanks and their crews or lesser numbers plus additional personnel. It, like the LCA, had a bow ramp that permitted troops to storm ashore, if necessary, without going over the side on nets into bobbing lighters. Many of these special ships were designed to offload almost on the beach and had the capability to back themselves out for return to deeper water and the next mission. These ships made possible the landing of immediately usable tanks, artillery pieces, trucks, and other weaponry, which permitted the amphibious operations to gain efficiency and effectiveness (148, 225).

The LST was probably the second most famous vessel of the war. It was used in all theaters to move tanks, cargo, or personnel and was a key element in any amphibious operation. The LST was 320 feet long with a 50-foot beam. It was not very fast, averaging only about 10 knots. But its two 900-horsepower engines and sturdy construction made it a seaworthy vessel. In rough and medium rough, seas, it could lead to instant seasickness for the uninitiated passenger or crew member. It had a large deck to hold 40 to 60 or more tanks at 25 to 40 tons each, plus other cargo and personnel. It had a bow ramp and low doors to enable easy offloading. It was designed to be capable of grounding itself on the beach. Often, the LST would carry pontoons to permit offload of the heavy tanks at sea when the beach was unsuitable for landing and discharge.

The LCT was a smaller vessel also designed to move and deliver tanks. It was about 160 feet long with a 31-foot beam and could carry three large tanks of 40 tons each. Or in an alternate use, it could haul 250 to 350 tons of cargo. Like its big sister, the LST, it was used worldwide and was a very valuable assault vessel.

Not all loading of attack transports was error free. Sometimes, the desire for security, secrecy, led to rather dumb conditions. For example, the loading of attack transports for the invasion of Attu in the Aleutian Islands was done under heavy security. Those responsible for loading were not told the mission or destination. The emphasis for loading, therefore, went on occupation supplies rather than assault and combat supplies. The loaders and load planners forgot that fighting supplies must be loaded to provide highest priority of offloading. Supplies were put aboard without regard for the consequences. High explosives were loaded in the same hold and same cargo area as gasoline. Fortunately, the conditions at Attu did not require the immediate supply support that should have been planned. This is just one more example of a failure to consider logistics (37:76)

Troops and support personnel were primarily moved by the Liberty and Victory ships, APAs, and LSTs as well as a great number of conscripted commercial lines. The luxury liner and the passenger freighter of the world's maritime lines became military transports for the duration of the war. Many military men and women spent long days and nights crowded aboard these vessels, moving from the United States to overseas and from port to port overseas. Many of these liners carried 5 to 20 times more troops than the passengers they had been designed to carry. Facilities were overworked, of course, and mess service, as an example, had to be carefully

scheduled. On some large troop movements, the men were fed one hot meal a day and one cold because that was all the facilities could support. Nevertheless, they got the job done, although there probably are not many ex-GIs who look back on those sailing days with nostalgia. In the 3-1/2 years of war, the Army Service Forces transported 6.9 million soldiers overseas, plus 250,000 Navy personnel, 110,000 civilians, and 30,000 people of other categories. That service also operated 1,765 ships by the end of 1944 while at the same time, of course, the Navy was operating thousands of ships in the fleets, support forces, and assault forces.

Air Transportation

Air transportation was vital to military success. The Ferry Command of the US Army Air Corps was established in early 1941 to deliver lend-lease aircraft to our Allies. In June 1942, it became the Air Transport Command (ATC) and took on added duties while retaining the ferry mission. It ferried 50,000 aircraft to overseas destinations during the war. The Naval Air Transport Service was activated in December 1941 with a mission similar to ATC—move personnel and cargo anywhere in the world and do medical evacuation where practical. Each Service also established troop carrier commands, which were, in reality, specialized air transportation within theaters of operation and in combat areas. The basic aircraft used were the cargo planes of the time—the C-47, C-54, C-46, R5D, and R4D—although quite often troops or cargo were flown via combat aircraft with a size that permitted the action. In addition, many units possessed small aircraft for their own airlift with limited range requirements. These aircraft were used for moving personnel and small supply loads short distances on short notice.

Air resupply was a must in many places during the war. To have such resupply, there had to be adequate ground support. Some figures were established for this purpose. Over time, it was found the average airstrip could handle approximately 500 tons per day. Therefore, if a geographic area required 1,500 tons of air resupply per day, it had to furnish three airfields. In those days, the primary transports were the venerable C-47 and the C-46. That quantity of air resupply would have required approximately 600 C-47 or C-46 sorties.

These 600 sorties would require considerable support over time to make them continuously worthwhile. Each sortie had to be offloaded and cargo moved on the ground. Generally, there had to be capability for fuel service and turnaround maintenance. That meant a requirement for aircraft parking area, ground equipment, fuel equipment, and so forth. Further, trucks and other vehicles were needed to move the cargo from deplaning to storage or use site. That meant still more equipment, maintenance, roads, and so forth. Then, too, there was a need for air-ground communications, airfield operations control, security forces, and so on. The problem was quire expansive and was not easily handled. The logistics forces always had to carefully plan for this form of activity. They certainly could not rely on just taking care of problems when they come up.

December 1935 saw the first flight of a true logistics superstar—the DC-3, C-47, or R4D aircraft. This miraculous airplane became a true superstar in military logistics. The original design from which the famed DC-3 sprang was for the DC-1. The *DC* stood for *Douglas Commercial,* and all the DC aircraft were originally intended for use as business aircraft or for airline service. Only one DC-1 was built. It made its first flight 1 July 1933 and proved the basic design. Modifications over the testing time produced the DC-2, which had 14 seats for passenger use. The first DC-2 flight was on 11 May 1934. There were orders for more than 200 of them, which meant big success for the manufacturer at that time.

American Airlines liked the DC-2 but asked Douglas to enlarge it to produce a sleeper aircraft for use on long cross-country passenger flights. The aircraft equipped with 14 convertible berths was called the *DST* for *Douglas Sleeper Transport*. It was a slightly bigger version of the DC-2 and was soon ordered by the airlines to be equipped with standard seating accommodating 21 passengers. Thus, the DC-3 was born.

The DC-3 had a wingspan of 95 feet, was 64 feet long, and its vertical stabilizer topped out at just about 17 feet. It weighed approximately 18,000 pounds empty and had a normal gross weight of about 25,000 pounds. Two Wright Cyclone R-1820 engines powered it, although a great number later had Pratt & Whitney R-1830 engines. It could fly at 180-mile-per-hour cruising speed covering a range of almost 1,500 miles. Its normal service ceiling was 22,000 feet, although later versions in military use flew much higher, especially in the China-Burma-India theater flying the *Hump* supporting China.

When World War II began, the DC-3 became a cargo aircraft as well as passenger airliner. Slight redesign for cargo flooring and cargo handling, including the familiar wide cargo door, were the major changes. More than 10,000 of them were produced for military service of the Allies. In addition, an indefinite number were produced by Russia, under license, with Russian identification. The US version became the C-47 in the Army and the R4D in the Navy. The British identified theirs as the Dakota. In World War II, the aircraft also became know as the *Gooney Bird*. No one knows for certain the origin or real reason for this nickname, but it is presumed to be in reference to a Pacific sea bird with great soaring capabilities, although the C-47 was definitely not a soaring machine.

World War II saw the aircraft used for transporting personnel; VIP transport; paratroop drops; cargo hauling in all theaters of operation; supply drops; observation; transporting animals, such as mules or camels; photo work; air-sea rescue; arctic support; survey purposes; and airways checkout, principally, medical evacuation of wounded personnel (91, 92).

In comparison to water and rail movement, the tonnage moved by air was small. However, the speed with which troops or critical supplies could be moved to the point of need made air transport invaluable. Further, airlift permitted troops and supplies to be delivered to otherwise inaccessible sites. It, therefore, became a new weapon of war. The stories of air support are many.

For example, during September and October 1943, one Australian infantry division, plus two air task forces and support troops, moved into the Markham Valley of New Guinea. This was an area surrounded by Japanese troops but essential to us for the strategy of neutralizing the New Guinea area. These Allied forces were totally supplied by air for several months, thus making the effort successful.

Another example was at the Kasserine Pass in North Africa in February 1943. Patton's troops had been forced back, and the Germans were pressing forward. Land mines were needed, but the mines were nowhere near. Immediately, the air movement began, and in 1 day, 100 tons of mines were delivered. The airlift continued for several days. The Germans were stopped, and the Allied advance resumed.

Probably not very well known was the air movement of materiel from overseas to the United States for essential war needs. For example, we flew supplies of platinum from Liberia, diamonds from South Africa, silk from China, raw rubber from the Amazon valley, and so forth. Many of these materials were so critical and so needed, the war effort could have been harmed had they not been rapidly moved. Of special note was the medical evacuation accomplished by air transport. Evacuation was, naturally, a humanitarian effort, but it also had a tactical aspect as well.

Not only were the wounded and sick removed to better medical care with greater probability for survival, but the evacuation also freed the combat unit of its ineffective troops and the need for personnel to care for them. Air evacuation was begun with considerable doubt from the medical world. It was thought flying would kill the patient, but it obviously proved quite different. For example, in the Mediterranean theater of operations, from the beginning of the Tunisian Campaign through the end of the Sicilian Campaign, more than 25,000 wounded were air evacuated, and only one patient died (313:6). Some experimentation was conducted in the China-Burma-India theater with helicopters for evacuation, but they did not get expanded use.

Air transportation also provided new capabilities for tactical air assault. This took several forms. One was to provide spotter aircraft for target direction of naval gunfire or land artillery afire. Another was the movement and dropping of parachute infantry, engineers, or sappers. Third, small airlift aircraft could deliver a few troops or small supply loads onsite even in combat areas. Fourth, they were often used to drop underground personnel and supplies in Europe. Fifth, though not too successful, was the glider insertion of troops for combat or reconnaissance.

The first combat use of the glider was by the Germans when taking the Maginot line from France in May 1940. General "Hap" Arnold started the Army Air Forces glider program in 1941 because, he said, it offered some advantages—it was silent, it could double or triple the load of a towing transport aircraft, and it could concentrate troops and weapons on a site instead of their being spread around with parachutes.

We built 16,600 gliders during the war. Most were 48 feet long with an 83-foot wingspan. The structure was a lightweight metal framework covered with doped and painted fabric. Each could carry approximately 13 soldiers and a Jeep or similar vehicle, plus radio gear and some survival rations. They generally proved ineffective and expensive. The glider required clear space for landing safely, and without that it wrecked, usually with heavy loss of life. We used them in the Normandy invasion, the attack on the Germans in the Netherlands in 1944, and some assaults in the Pacific. On the whole though, they were useful weapons for the time, but they must be classed not very successful in our war efforts (51).

Supply

Historically, the technical services of the Army had their own supply functions. There was the Quartermaster, Ordnance, Signal, Chemical, Medical supply, and the like. However, to help in solving the huge distribution problems and to aid in requisitioning, supplies in the Army were given class designations as follows:

- Class I—Supplies that were used at a fairly uniform rate regardless of the situation. This was principally food.
- Class II—Clothing and weapons for which there was a specific table of allowance (TA), such as for individual soldiers or for specified organizations.
- Class III—Petroleum products of all kinds, except aviation fuels and lubricants, which were Class IIIA.
- Class IV—These were miscellaneous groups of supplies including construction materiel, fortification materiel, and other special purpose supplies.
- Class V—Ammunition, other explosives, and chemical agents were the prime items in this class (119:493).

Tables of allowance were established by the Army for specific needs. For example, there was a TA for the individual infantry soldier that outlined all the necessary personal and weapon equipment. Therefore, requirements determination was simplified when the planners could multiply each TA supply need by the number of men to be supplied by its authority. This often caused the individual soldier to be overequipped, much as he had been in World War I, and a lot of waste was incurred because the soldiers discarded the excess as soon as they could (119:495).

Similarly, a TA existed for specific types of organizations. Thus, there was a TA for a quartermaster truck company, a field artillery battalion, an air force service squadron, a bombardment squadron, and so on. The same faults appeared. Units were overequipped in some respects and under-equipped in others because the TA did not and could not take into account the situational and environmental differences for individuals or organizations or the effects of changing combat conditions and the subsequent losses of supplies and equipment.

Obviously, the needs for supplies differed between the theaters of operation. The needs in the Aleutian Islands, for example, were a great deal different from the needs of the steamy jungles of Burma. Yet, until the system permitted

tailoring, each was considered the same. The TA scheme was a great help for the initial structuring of an organization or for initially equipping a man. Beyond that, there was considerable doubt about its effectiveness.

Initial issue on the basis of the TA was automatic. A new unit did not have to requisition its basic equipment because the supply system automatically distributed the TA items to it following issue of its activation orders. Correspondingly, the equipment and supplies for the individual soldier were automatically shipped to the unit on activation. Nevertheless, the TA created a great deal of waste and a drain on the distribution and transportation systems.

There were two supply systems in the Army. The Army Service Forces provided all Army units with common use supplies such as food, clothing, ammunition, fuel, and medicines. The Air Service Command was responsible for supplying all *Air Force peculiar* materiel including such items as aircraft, flyers' clothing, and other aviation materiel. Research and development of these items was the responsibility of the supplying authority. The Army Service Forces was responsible for most recruitment (until 1943 when volunteer enlistments were stopped) and training of people (except aviators). The conflict between the two systems was pretty much continuous through the war, although both supply systems did become effective and capable.

The Army supply systems began the war using a scheme of *push* supply. Somewhere, a headquarters decision was made about who would receive what and when. That materiel was automatically shipped without the unit's requisitioning it. Thus the supplies were pushed to the units. Some items of unusual use (aviation parts, for example) could be requisitioned and were shipped only in response to requisitions thus pulling supplies from the depots. As the war wore on, the systems changed to both push and pull. By middle 1944, the systems were essentially on pull except for supplying troops actively engaged in combat and for unit supplies of ammunition, food, and fuels, which remained on the push concept (119, 148).

The supply systems were often ineffective and failed to meet needs in a timely fashion. Early in the war, of course, this could be expected because of the great overall confusion and tremendous activity. Later, though, there seemed no really good excuse for the problems. For example, in mid-1942 at Espiritu Santo, New Hebrides, it took 3 months to get sufficient lumber to build a control tower higher than the palm trees, an essential for aircraft traffic control. Further, there were not enough supplies to build safe circulating taxiways for the fighters and bombers. The result was that it took 1 hour to get 12 B-17 bombers off the ground. Getting them back on the ground, particularly after dark, was a long hour and a half. Often the aircraft had wounded aboard on return, and delays were dangerous for them. More important, the ground delays meant that each aircraft sortie was cut short by 2-1/2 hours, and fuel reserves were cut to dangerous margins.

Supply in the Navy and Marine Corps continued through the war pretty much as it had before the war. The only major change was to accommodate the huge increase in size of the fleet and the corps and the highly dispersed geographic locations. The Navy, because it had so much experience with dispersed supply, having operated its fleets all over the world for many years, provided supplies with what seemed to be greater efficiency than did the Army. Many Army troops complained that the Navy seemed able to provide *good stuff* to its people when the Army could not. For example, in 1943 on Espiritu Santo, the Navy constructed and operated an ice cream factory and store while the Army troops were struggling to make palatable the dehydrated and canned foods they received (184).

Navy ships stores had a fairly wide range of items for their customers, while Army troops most often had no exchange or, at best, nothing more than a few shelves in, perhaps, half a tent. The Army's meager exchange system in combat areas offered little more than toothpaste and a few small candy confections plus shaving and cleaning supplies. Yet, the Navy, as it seemed to the Army personnel, had small department store inventories. Other official military supplies were also seen as more bountiful and higher quality for the Navy than for the Army.

Both the Army and Navy suffered from inadequate coordination of shipping of supplies. Logistics scheduling was partially at fault, but most fault could be laid on the absence of adequate preparation for handling ships and cargoes. For example, Noumea, New Caledonia, could handle only 24 offloadings a month in its limited port facilities. Yet somehow, for a long period, 48 or more ships per month were scheduled into that port. Attempts were made to offload to lighters and barges to relieve the port problem. But a lot of cargo was lost due to improper handling, and also, a lot could not be moved because the ships carried cargo too heavy for their on-board cranes. The result was a serious shortage of vital supplies urgently needed for combat—supplies such as aircraft engines, petroleum, radar sets, and the like.

In late 1942 and through 1943, ships with these urgently needed supplies often lay waiting at anchor at Noumea for up to 3 months until they could move into dock. Not only were the supplies unavailable but also the urgently needed ships. On other islands, such as Espiritu Santo and Guadalcanal, the conditions were even worse because there had not been even the beginning of port facilities when the American forces moved in.

Combat was totally dependent on supply, of course. Ammunition, medicines, petroleum, and the like were essential for combat success, so some means of constant supply was necessary. Most often, the basic resupply came from water transport then via some form of ground transport as, for example, when bearers had to be used in Burma, bearers in New Guinea, animals in North Africa, and vehicles in other areas. Sometimes air supply was needed because of the terrain between supply storage and the combat point. An example was in August 1942 when General George C. Kenney was charged with stopping the Japanese who were advancing on Port Moresby, New Guinea. He used the only 31 transport aircraft available (19 types including a Ford trimotor and a Fokker trimotor, among others) to fly an American regiment into the area. They stopped the Japanese. A short time later,

Kenney flew the 32[d] Division into Buna and fully supplied it with food, ammunition, artillery, trucks, and cannon. They were successful in halting the Japanese advances, and the reversal of the Japanese successes began (130).

Surprise was a constant factor for supply agencies, locally or globally. In illustration, we will look at the time of the Japanese efforts to force the Americans off Guadalcanal in October 1942. The Japanese fleet attempted daily to relieve its forces on the island and eject the American assault troops. This led to continuing naval battles as well. On 26 October, the carrier *USS Hornet* and the destroyer *Porter* were sunk in battles off the island. One result of these losses was a new and totally unexpected logistics problem. The US Navy base at Noumea was suddenly faced with immediate support needs for an additional 3,000 nearly naked survivors of those sinkings. With the cooperation of the local US Army forces, tents were erected, cots provided, mess halls established, and a whole, functioning camp provided. Clothing was gathered from all available ships, so each survivor was given one set of underwear, socks, shoes, and dungarees. None of this had been anticipated, and supplies were not provided for such needs. The lesson learned from this soon required all ships to carry extra clothing, tentage, and support supplies. Later, the fleet service squadrons carried plenty of clothing and supplies for such contingencies. Additionally, barracks ships were made available to immediately house survivor groups if necessary (37:42).

There was a lot of *make do* by the forces to accommodate to the lack of supply at times. For example, crashed aircraft were often cannibalized thoroughly so the parts could be reused. Parts for aircraft, ships, engines, trucks, and so forth were frequently locally manufactured. Often these local parts lacked the niceties of commercial manufacture, but they served to get equipment back into use rather than lie idle awaiting parts. As far as possible, the technical orders and specifications were observed in these actions, but the urgency of the situation frequently made local standards and capabilities displace the original technical standards. In almost every instance, this was successful and contributed significantly to mission accomplishment.

The original supply planning for the Army and Navy was to have 120 days of supplies on hand before an invasion in the Pacific. Soon this was reduced to 90 days of supplies, then to 60 days, then to 30 days, with the ATC and NATS providing essential supply support by air. When, in October 1944, we returned to the Philippines through the invasion of Leyte, the invasion troops had 5 days of supplies with ensured air supply until water transport was readily available. Air transport supplied everything for the troops (Army, Marines, and Air Forces) until the cargo ships could do the job. Again, though, there was no adequate port facility at the invasion site on Leyte, and shipping congestion became the worst in an already bad Pacific war history (119:544). With hard work and a lot of frayed nerves, offloading took place and resupply was done so the air transport could be otherwise used.

This was a war of large numbers and huge quantities. Lead time for supplies was long. In Europe, for example, the order and shipping time for most supplies averaged around 120 days. Replacing tanks in Europe required 135 days of supply in the pipeline at all times. The tank replacement rate was 11 percent, and there were 4,000 tanks authorized units on the Continent. Therefore, there always had to be approximately 2,000 tanks in the pipeline (206:507). It is understandable that there was confusion and waste in the systems of supply when the mass of materiel is considered.

All in all, the supply systems worked effectively, and troops basically received what they needed in time to do the expected job. Certainly, there were specific delays, which caused consternation and disgust, but overall, supply succeeded. However, with all its planning, the supply systems did not properly anticipate the problems of supplying troops who were in rapid advance chasing the enemy.

For example, in August 1944, American troops began a rapid chase of the Nazi forces in Germany. The logistics system was not prepared to handle that rapid movement. It had no rail transport, no pipelines for petroleum, too few people, and too few supply sites in advanced areas. The rapidly moving armies defeated their own logistics system and were forced to stop.

Leyete operation, 1944. Twenty landing ships, tank, pour Army equipment ashore on Cataisan Point, near Tacloban City, Leyete, during the buildup of US forces there, circa late October or early November 1944. Note large number of vehicles parked on and near the airfield and the wet conditions there. The two most distant LSTs in upper right are *LST-740* and *LST-1014*. (Courtesy of National Archives)

The story of Patton's forces is well known. In an effort to meet the supply needs, the logistics systems used its available motor transportation to destruction. This, of course, merely added to the problem. As supply and logistics troops labored to try to meet needs, they found themselves unable to offload ships correctly, unable to correctly sort and store supplies, and unable to establish forward supply points. The effects of this were felt until war's end (206).

Storage was always a problem. By war's end, the Army Service Forces (not including Air Forces, Navy, Marine Corps, or Coast Guard) had 127 storage depots involving 145 million square feet of storage space. They were shipping 2.5 million tons of supplies per month. Plus, they were receiving more than 2.5 million tons per month in new supplies, so the storage problem continued to grow.

Warehousing and storage for all the Services was a fantastically complex and demanding job given the variations in climate, environment, and capability. We should think about the complexities and difficulties of storing materiel, such as photo supplies, in hot, humid, mold-inducing climates; the problems with keeping flight clothing free of mold or vermin in hot, humid climates; the retention of utility of foodstuffs in extreme cold, high moisture, various temperature ranges; and so forth. The supply personnel did a wonderful job under the conditions they had to live with. The lessons learned in this war should not be overlooked or forgotten by logisticians.

Maintenance

In this war of mechanized mass, maintenance quickly became the major determinant in combat and support capability. If the equipment did not work, the mission was under threat. The mechanics and engineers who took care of and repaired mission equipment were very important to the unit. Commanders learned quickly they either had to give time for essential maintenance, or they would suffer for the lack and perhaps fail in mission efforts.

We must remember that, in every instance, combat means damage to equipment. The more we depend on equipment for combat success, the more important the care of that equipment. Thus there is created a need, bordering on always being urgent, for immediate maintenance and repair capability to support the combat forces. Further, for mobile equipment (trucks, other vehicles, tanks, trains, ships, and so on), that maintenance support must be close to the action and sometimes, as on ships, part of that action.

The need for maintenance and repair after combat may range from relatively minor to very extensive, up to the point of despair. The nearer the required maintenance capability, the better. The nearby capability avoids as much as possible the need to evacuate or abandon the greatly needed equipment. When we must evacuate or abandon the equipment, unless we have immediate replacement for the combat forces, we weaken combat capability. We leave ourselves open to potential heavier losses from an equally or better equipped and maintained enemy force.

Further, whatever must be evacuated creates demand for at least double transportation—one for replacement, one for evacuation. This demands more supply, security, storage, manpower, bases, and money—more of all that constitutes logistics. And all of this may further bleed capability from the combat forces.

When the war began, the Army still operated under philosophies and concepts created in World War I. Each Air Corps squadron was essentially self-sufficient and more or less responsible for its own tactics and logistics. Even when employed in *groups,* this was true because self-responsibility held even then. Squadrons operated from fixed bases, and little thought was given and practically no planning was devoted to mobility. Mobility was thought of in relation to aircraft speed and range but not much else. In general, the air philosophy was small aircraft carrying small ammunition or bomb loads. There was little thought for extensive supply or maintenance support (85:55) The controlling scheme was that the Air Corps, later the Air Forces, could be self-sufficient and responsible for establishing and operating its own bases.

Of course, the prewar Air Corps was small. It had only 17 stations in the United States, and these were all permanent bases, with permanent buildings and permanently installed maintenance equipment. Those bases were serviced by four control depots, which were also permanent. There were no mobile units, and very little of the existing equipment was suitable for extended field use away from the base. Occasionally a small depot support team would be created and dispatched for maintenance onsite support, but this was the exception rather than the rule. Logistics support with all its ramifications was based on World War I and the technology of the 1930s. There was no meaningful forward-looking preparation for anything other than what existed. In support of this, it must be mentioned that nowhere in the world did there exist any data that would have caused this existing structure to be challenged. After all, no one had ever experienced aviation in war except for World War I (85:55-58). Those individuals who saw things differently were not welcome in the planning groups.

In the Army, maintenance was accomplished through a series of four echelons. The definitions were directed at assigning responsibilities for maintenance as well as helping to decide the various tables of allowances for tools and equipment. An illustration of the echelon definitions for the Air Forces in early 1942 is in Figure 3.

Early in 1941, the Air Corps established the airbase group, which was composed of a headquarters squadron, a materiel squadron and the technical services (ordnance, signal, and so forth) to support three to four flying squadrons by performing through some portion of the third echelon of maintenance. In 1942, the airbase group became the service group, with two service squadrons, one supply squadron, and a headquarters squadron, plus the technical services. The service group was designed to be mobile and responsible for third echelon maintenance support of one or more combat groups.

Also, in 1942, the air depot group was created, and it had a headquarters squadron, one supply squadron, one repair

squadron, and the technical services. The depot groups were to operate fixed facilities and have mobile teams for onsite work with particular attention given to combat theater needs.

The service squadrons in the Army Air Forces were maintenance support for the combat organizations. When maintenance was required beyond the capability or available time of the combat squadron or group, the aircraft was turned over to the service squadron. Or sometimes, a mobile repair unit from the service squadron would go to the aircraft. That was particularly true if the aircraft had crash-landed or been forced down at some remote site (78).

Each service squadron had a complement of highly qualified technical specialists in a wide range of skills. These included welders, machinists, sheet metal repair, instrument repair, electricians, radio repair, photo and camera repair, engine repair and overhaul, propeller repair, and so forth. These men had special tools and equipment items and extensive shop equipment to back them up. Further, each service squadron normally had trailers (large semitrailers fully enclosed) for the instrument and machine shops and a special *box* for bombsight repair.

The shops were almost always in tents in the Pacific, often in tents or Quonset huts in other theaters. The men assigned to the shop would, over time, have arranged to provide wooden flooring for the tent and often some form of screening (usually made from mosquito netting) to fend off the bugs.

The trailers were compressed shops. That is, they were full shops tied to a very confined space in the enclosed, weatherproof trailer. The equipment was stored away when not in use, except for the larger items like a lathe or drill press. Each had its own power source, a large generator housed in the front of the trailer, and a good-sized air compressor. Power and air were piped to various locations throughout the trailer. The instrument trailer was air-conditioned, as was the bombsight box, and always a welcome place for others to visit. Each trailer was fully mobile for use by the mobile repair teams or for squadron movement.

Close by and allied to the service squadron would be the other elements of the service group, including an ordnance company for ammunition and explosives and similar materiel, a quartermaster truck company for just what the title implies, a signal company for telephone and ground radio service, perhaps a second service squadron, and a headquarters squadron. Approximately 400 specialists would man each service squadron.

They could and did do marvelous things, including almost total rebuild of an aircraft when aircraft were in short supply. Many component parts were manufactured in the shops, even though the original manufacturer had not intended them to be, so the aircraft could again be flown. Reclamation of crashed aircraft on the local airstrip or out in the remote areas was an act of mechanical beauty. Often, the residue after completion of the reclamation could not be recognized as the aircraft and all the reclaimed materiel were soon tested and put back in use when practical. This kind of activity was often the only source of critical parts and essential to combat capability of the units being serviced (78)

Additionally, the service squadrons had a technical supply element that served as the supply source for a great many essential resources and parts, for the service squadron as well as the serviced units. A drafting shop also was of great help in laying out and providing specifications for parts to be manufactured or undergo major repair or overhaul.

In general, the Services struggled to find the best way to do maintenance under the highly volatile conditions of World War II. In aircraft operations, the problem was intensified by

US Army Air Forces Regulation 65-1, 14 August 1942, defined the echelons of maintenance as follows:

1st Echelon. That maintenance performed by the air echelon of the combat unit. This would normally consist of servicing airplanes and airplane equipment, preflight and daily inspections, minor repairs, adjustments, and replacements. All essential tools and equipment must be air transportable.

2d Echelon. That maintenance performed by the ground echelon of the combat unit, airbase squadrons, and airways detachments. This would normally include servicing airplanes and airplane equipment: performance of periodic preventative inspections and such adjustments, repairs, and replacements as may be done by the use of handtools and mobile equipment authorized by tables of basic allowances for issue to the combat unit. This includes engine change when the organization concerned is at the location where the change is required. Most of the tools and equipment for second echelon maintenance can be transported by air, but certain items—such as transportation, radio, and so on—necessitate ground means of transportation.

3d Echelon. That maintenance performed by service groups and subdepots. This maintenance embraces repairs and replacements requiring mobile machinery and other equipment of such weight and bulk that ground means of transportation is necessary. Units charged with this echelon require specialized mechanics. This echelon includes field repairs and salvage, removal and replacement of major unit assemblies, fabrication of minor parts, and minor repairs to aircraft structures and equipment. Normally, this echelon embraces repairs that can be completed within a limited time period with the period determined by the situation.

4th Echelon. That maintenance performed by air depot groups and air depots. This includes all operations needed to completely restore worn or damaged aircraft to a condition of tactical serviceability and the periodic major overhaul of engines, unit assemblies, accessories, and auxiliary equipment, and the recover, reclamation or repair, and return to service of aircraft incapable of flight.

Figure 3. Echelons of Maintenance

the introduction of a mass of new technology and huge new airframes. The Navy adapted the floating dock and its traditional tenders and repair ships for fleet support. Aviation maintenance continued to be a squadron responsibility, for the most part, supported by the ship's crew and by land-based maintenance support functions when close enough to help. Marine and Army ground forces had their own maintenance people assigned, and they generally were with them through the thick of combat and did what they could to keep tanks, trucks, radios and other equipment in working order. They did miraculous things and were amazingly effective, considering the conditions under which they worked in all theaters. The Air Forces assigned maintenance people to combat units to do first and second echelon maintenance. The service groups and depot groups then served as supporting agencies to the combat groups (2).

The Air Forces attempted to provide mobile depot support to combat units through a project known as the Army Aircraft Repair Ship. The idea was to outfit and man a group of Liberty-type vessels as floating Air Forces depots. Each such vessel would be supported by three or more auxiliaries known as maintenance ships that would be smaller than the Liberty. The first such ship was readied for use in late 1944 and moved to the Philippine Islands for duty. It was, though, too late, and combat conditions had changed. So the manpower and equipment were removed and put to work in fixed, land-based depot facilities (2:15). The scheme for a floating depot was not successful then, but the idea carried forward into later Army use for helicopter support in Vietnam.

The B-29 aircraft brought new problems to aircraft maintenance. It was a state-of-the-art aircraft with much new technology that jumped from design to hardware without opportunity for proofing. The aircraft had many service problems and many reliability problems. Maintenance requirements were so heavy the number of combat sorties was greatly reduced due to lack of available ready aircraft. This resulted in the development of specialized aircraft maintenance in the Air Training Command, which was amazingly successful in increasing the readiness and availability of the B-29. The idea was to specialize personnel in specific tasks so they could perform them faster and with greater reliability. Thus, engine change crews, wheel and tire change crews, inspection crews, and so on were created. This effort migrated to the Twentieth Air Force in the Pacific, and the B-29 combat efforts greatly improved with more aircraft availability and improved reliability. However, specialized maintenance did not spread to other aircraft, and it suffered neglect when the war ended and was shortly discarded until resurrected in 1949 in the Strategic Air Command (183).

The Air Service Command published *Maintenance Division Circular Number 28*, on 15 February 1944, which created the production line maintenance operation for the B-29 and B-24 training operations in the United States. This directive borrowed heavily from the production line functions of the prewar automotive industry and applied the techniques to the performance of periodic inspections of the aircraft. It, coupled with specialized maintenance, made for a highly effective maintenance operation for the wartime training command. It was from this experience that the Twentieth Air Force developed its maintenance concept for the Marianas.

The Air Forces, Army, and Navy experienced a lot of improvisation by maintenance people during the war. After the fact, this innovative work is praised and the participants are proud of their accomplishments. But, at the time of the event, such action consumed time, man-hours, skills, and materiel sorely needed in other tasks. Plus, they were not always so effective, although they seemed to get the job done. For example, on Guadalcanal, in 1942, the 67th Fighter Squadron flight personnel had to do their own maintenance on their aircraft because there were no maintenance people to support them. The result was a flood of self-induced problems, system and parts faults, and some probable aircraft losses. There were maintenance people available in the theater but not on the island. There were parts, hundreds of thousands of pounds of them, somewhere in the system, but their locations were unknown to anyone able to get them moved.

The floating drydocks were an innovation that proved exceptionally helpful to naval logistics. These were formed by using prefabricated independent units side by side and welding or otherwise tying them together. They were equipped with huge pumps to expel water, power supplies, living quarters for 60 or more men, kitchen and refrigeration equipment, night lighting, and very well-equipped repair shops (37).

The floating drydock installed at Noumea, starting in late 1942, was 485 feet long and able to lift 3,500 tons. It was of suitable size to handle a destroyer, submarine, or LST but could not handle any larger vessels. Later, on Espiritu Santo and at Manus, Admiralty Islands, and on Guam, a much larger unit was installed. It was 844 feet long and could lift 81,000 tons. It could handle the largest ship in the Pacific with ease. Additionally, there were smaller units of varying sizes able to lift 1,000 tons and handle almost all of the support vessels. The workload of these floating drydocks and repair units was tremendous. As an illustration, in March 1944, the units in the Solomon Islands repaired 261 vessels that month, alone (37:54).

When the dock was to be used, the crew would flood the ballast tanks, sinking the dock. The ship needing repair would then be floated into the sunken dock. The necessary support structure would be placed under and around the ship. The pumps would expel the ballast water raising the dock to its floating level. The ship would gradually emerge from the water to be high and dry on its support structure and ready for repair actions. This was an invaluable asset in the Pacific, primarily because of the absence of developed port facilities almost everywhere the Navy was required to operate (37).

The bulk of naval vessel maintenance was performed by the crew of the vessel. They had been trained for certain maintenance tasks, and they did them very well. The ships relied upon repair ships, tenders, and the shore facilities for that maintenance and repair beyond crew capacity, and much of the support capability was mobile. That is, it was able to move to new locations, not always with ease and quickly begin serving the fleet at a new site. The tugs, floating docks, floating

drydocks, and support vessels were absolutely essential for the fleets' combat capability.

The Normandy invasion of 6 June 1944 depended on naval support. The Navy was the primary troop transport and the initial heavy fire support for the invasion. The naval objective was to provide properly timed arrival and landing of the assault forces at their assigned beaches. Further, the Navy had to provide cover for the assault, support after the landings, continuous ferry service on schedule, the buildup of the onshore troop force, and immediate reconstitution of the fleet's combat capability.

To do this, a rigorous maintenance program before D-day was employed to ensure the ships were operationally ready and able to do their expected job sustaining the assault mission. The D-day preparation schedule required 80 percent of the hundreds of vessels to be operationally ready at all times for training and exercises. The ships constantly practiced and exercised their roles, and that preparation paid off. On the actual D-day, only 14 of the more than 2,400 US ships scheduled were unable to participate (36:374).

In the Pacific operations, Navy ships experienced severe maintenance and repair problems early in the war. The Japanese were able to accomplish almost continual submarine, surface, and air attacks against US vessels. They bombed, strafed, and torpedoed on a continuing basis in the area of the Solomon Islands. In October 1942, for example, in the Battle of Cape Esperance, the US cruiser *Salt Lake City* was severely damaged. It had to be temporarily patched by the crew and sent to repair in Sydney, Australia. There were no facilities or maintenance capabilities in the area at that time. The same was true for the damaged cruiser *Boise*, the destroyer *Farenhold,* and others. Thus, these already damaged vessels were exposed to further peril during their slow voyage to Sydney, and even more important, they were lost to the fleet for longer periods (37:35-42).

As the Navy built up capability in the South Pacific, the needed shipboard maintenance was done almost totally afloat. This was due to the lack of port facilities in the islands and the lack of time to create them before combat was experienced. As people, equipment, and time permitted, the port and shore support was improved and extended, and major maintenance was provided the fleets. Not all of it was fully successful though. On Espiritu Santo, a torpedo overhaul shop was established. In the 2-year period of operation (1943-1945), it received almost 2,700 torpedoes for overhaul and completed overhaul of 2,500. Of these, 2,100 were reissued to the ships of the fleet. The quantity of work performed was fine and highly acceptable. The quality of that work was not satisfactory, though, and was a continuing complaint from the fleet. The degraded quality was related to four factors that were not corrected adequately through the entire period. The factors were:

- Generally poor quality of the torpedo itself until after late 1943.
- Inadequate, rushed training of the maintenance personnel.
- Work conditions in the torpedo shop on the island.
- Work overload and constant urgency that resulted in extreme psychological pressure (37).

Other maintenance was also required. Vehicles of all kinds required constant maintenance support. Buildings, runways, roads, taxiways, piers, and so forth needed care and attention. Some of the materiel used was not helpful in reducing maintenance needs. The pierced-steel planking used for airfield runways and taxiways disintegrated rapidly. The planks buckled and loosened creating runway/taxiway hazards and dangerous cutting conditions for aircraft tires. Constant maintenance was required on many airfields because the surface below the PSP modified in heavy rains and washed away. This created voids, which worsened the PSP disintegration and caused some very serious aircraft-handling conditions that were not desirable with bomb-loaded aircraft or medical evacuation aircraft, in particular.

Maintenance was a major problem throughout the war. All the corrective actions through the war helped, of course, but maintenance never achieved freedom from urgent demands. The logistics support for maintenance was generally good after the initial period of inadequacy. The equipment maintained was, in the long run, able to do its job. Maintenance did, indeed, do what was expected of it and did it very well considering everything.

Food

Far back in history, someone said an Army travels on its stomach. How true. And a Navy, as well. Food supplies were a major element of World War II logistics. Before the war, the War Department operated its Army troop messes as garrison food service in which each squadron had its own kitchen. Each such mess was financed by a given sum per month, per soldier eating in the mess. The kitchens were locally controlled, and the mess sergeant could purchase through the commissary or the local economy as he wished. Food service was, on the whole, very good, and certain messes acquired reputations for their specialties. This locally controlled food service was naturally not adaptable to the requirements of combat and the mobility of forces in many uninhabited areas, so the control of menu, purchasing, and preparation was centralized.

The Services recognized food had great impact on morale and great potential for harm to the physical ability of troops to perform. It was also obvious that food could alter the health of the troops, so every effort was made to provide a nutritious meal service worldwide. Nevertheless, subsistence became and stayed a principal logistics problem throughout the war. Much of what we experienced in the war had not been experienced before—at least not in the magnitude of our effort. No one had ever before attempted to provide food service for more than 12 million people at hundreds of locations worldwide.

It should be no surprise that the number one gripe of the serviceman and woman during World War II was food—quality and preparation. This complaint held true no matter what was done to improve conditions. The imagined or real low quality of food preparation caused a lot of food waste. GI cans at mess

facilities were frequently filled with food taken but not eaten. Many food service facilities began, early in the war, to display signs urging care about food waste. The signs were carried over into the messes in foreign areas as well. Most of the signs read somewhat like the following:

Take only what you can eat. Eat all you take.

Food for troops in the Continental United States was a considerably different problem than food for any of the theaters of operation. There were not only geographical differences but also climate differences and differing effects on human metabolism. Food for combat areas had to be easily moved, yet palatable and edible after relatively long-term storage. It also had to be capable of being prepared by the individual or a group under the harshest conditions.

Food packaging had to protect the contents against tropic heat, arctic cold, desert sand and heat, jungle humidity, and sometimes almost constant rain. In addition, the packaging had to prevent vermin infestation and had to resist the efforts of small animals to get at the contents. The packages of certain of the foodstuffs had to be light enough, even with all that protection, to be carried readily by one man in his pack with his other combat gear (148).

Many of the meals to be issued to the individual had to be edible whether hot or cold because very often, in a combat situation, no fire could be lighted for heating food. Then, to cap it all, there were the considerations that had to be given to special foods for submarine crews and their tight environment and for aircrews and their peculiar environment. It was a big problem.

To assist in meeting the food needs of the worldwide dispersal of troops, the Services developed different kinds of rations for troop use. The Army was made responsible for the supply of dry rations to all Services worldwide. This created some difficulties.

The Army developed a classification of rations for its food service worldwide. The classification attempted to take into account the range of conditions and needs to be faced but only partially succeeded. The ration classes were:

Field Rations

There were two classes of field rations that evolved from a central menu control operated by the War Department.

- **Field Ration A** consisted of 70 percent fresh foodstuffs, which included dairy products, fresh fruits, eggs, and meats. Obviously, Field Ration A was essentially limited to the United States and those overseas areas where the local economy could support it.
- **Field Ration B** was almost 100 percent nonspoilable foodstuffs in cans, dehydrated packages, or dry. It was readily shipped and stored and was, therefore, the principal food supply for overseas troops, particularly those in areas with no local economy (119:483-5).

Combat Rations

Combat rations were small, personal meals packaged in small cans or packages. They were designed to be carried and prepared by the individual soldier.

- **Combat Ration C** consisted of two small cans that contained a meat dish (usually hash or stew), a beverage powder that could be mixed with the soldier's canteen water and a sweet, which was usually a candy drop.
- **Combat Ration D** was a concentrated bar of edible material that approximated 600 calories. It was made of cocoa, oat flour, and skim milk. It was classed by the troops as normally inedible and fit only for animals, yet it was of use in trading with local people who were worse off than the soldier. Also, it did prove its worth when the hungry soldier in combat needed food and nothing else was available.

Other Rations

Later, there was added the famous K-ration, which was a waterproof box containing one meal for one man. It could be carried in the soldier's pack and saved for a long time. It was edible hot or cold, although much of the canned content could be very unpalatable cold. Aircrews used a lot of the K-ration, as did some troops who thought they could do better than their unit mess by preparing their own food using boxes of K-rations.

Probably the most favorably received were the 5-in-1 and 10-in-1 rations introduced near war's end. These packages were prepared for feeding small groups such as tank crews or aircrews. Further, they could easily be shipped for the food support of isolated detachments that could not be provided a full mess capability. These seemed to have better quality foods and were large enough to feed five to ten people, so they had some variety. The troops would trade contents and prepare their own meals for platoon, tent, or other small group.

All in all, though, food was generally rated unfavorably by military personnel worldwide. The situation worsened when Army people compared their food with that of the Navy. The Navy and Army did not seem to provide the same foodstuffs, although the Army was the common provider of dry foods. The Navy food service seemed to Army people to be inordinately better. Even in combat areas, the Navy seemed to have fresh foods and ice cream on the larger ships, such as the big aircraft carriers. For the Army, fresh foods and ice cream were dreams of home not to be realized in Army mess tents (184).

Regardless, the Services did provide adequate food to keep the troops alive and physically capable of doing their jobs. It took a lot of effort and a lot of logistics to do that. In the European theater, it took 7 pounds of rations per day per man to keep the forces going. In the Pacific and China-Burma-India theaters, it took 6-1/2 pounds per man per day, probably due to the different climates involved. The impact on overall logistics support is obvious when you multiply those daily needs by more than 12 million personnel (119:495).

Potable water was equally important and received equally chilling comments from the troops. In many areas, the water was mineralized or otherwise different from the taste to which people were accustomed. In all areas outside the United States, the water was heavily treated for purity and usually had a decided medicinal taste. In foreign camp areas, the water was stored in mobile tanks or canvas lister bags, both of which seemed to add a distinctive and unwanted flavor.

In many areas, there was no suitable water source. Many areas of the Pacific, for example, offered no safe, large quantity source of water without heavy treatment to rid it of dangerous bacteria. On Manus, Admiralty Islands, the Navy set up a water supply system capable of producing 4 million gallons per day. At Tulagi, Solomon Islands, the Navy supplied 21 million gallons of purified water to small vessels in just 2 weeks. The demand was so great in the Pacific that the Navy changed two newly commissioned oilers to handling pure water as their sole product (37).

When an amphibious assault was planned, the Navy arranged for water to be taken ashore to allow 2 gallons per man per day for the first 5 days. It then moved distillery equipment ashore to provide an operating 5 gallons per man per day indefinitely. That quantity was adequate for basic needs. The larger ships had distillery equipment aboard and converted seawater for personnel to use. But this, too, could create problems. For example, when the Philippines were invaded, a great number of troops ashore and on ships were stricken with severe gastroenteritis and dysentery. The cruiser *Alaska* alone had 423 cases at one time. The cause was determined to probably be the fact the shipping in San Pedro Bay could not be provided garbage disposal service. The ships held off as long as possible but finally had to dump overboard. The bay was full of floating garbage, and the distillery equipment could not handle the cleanup. (37:203).

In the Mediterranean theater, the Navy supplemented the Army-provided dry rations with shipments of its own fresh and frozen foods. It arranged for provisions stores ships to make regular runs supplying the fleet. The provisions ship *Tarazed* provided, for example, frozen and fresh turkey, chicken, mutton, frankfurters, and boneless beef. The boneless beef was used because it saved weight and could be more easily stored and handled in 33 pound containers. Further, small ships and shore detachments could handle boneless beef when they would have difficulty with large bone-in cuts. Frozen vegetables were provided in 2-pound packages. Fresh fruits and vegetables were in 5- and 10-pound bags. The favorite food item of the Mediterranean was frozen strawberries, which came in 5 and 25 pound cans (36:293-5). All of this eased the dissatisfaction with the dry provisions, but the Navy could not supply all Army troops as well, unfortunately. Perhaps this accounts for some of the stated Army troops' dissatisfaction with their rations and conviction the Navy had a *better deal.*

In preparation for the invasion of Italy in 1943, the Navy practiced for the Salerno landings. While getting ready for this assault, the Navy was feeding more than 100,000 men, 45,000 of them troops on the transports and landing craft. As we have stated, the Navy was totally dependent on the Army foodstuffs here as well as in the rest of the world. The Army was currently feeding more than a million troops in the Mediterranean theater. Its supply of dry provisions was adequate, and the Navy had no complaint about either timeliness or quantity of such foods. But Navy personnel demanded more fresh and frozen foods, which is why the Navy went to the special provisions stores ships mentioned earlier.

The provisions ships carried quite large cargo loads of foodstuffs plus mail, which was very welcome at all times, and 500 or more passenger troops as an element of defense water transportation. A normal provision load for one ship, the *Merak*, was:

- Fresh fruit 175 tons
- Potatoes 500 tons
- Other fresh vegetables 175 tons
- Smoked meats 140 tons
- Boneless beef 225 tons
- Other fresh meats 228 tons
- Butter 45 tons
- Cheese 18 tons
- Eggs 100,000 dozen

The total load was more than 1,500 tons (3 million pounds) and was later increased to more than 1,700 tons to help meet demands (36:296).

There was a shortage of refrigerated storeships, so the Navy developed the refrigerated barge for use in the Pacific. The barge was not self-propelled but was moved by tugs when necessary. The value of the barges rested in their ability to offload a refrigerated storeship in short time, releasing that ship for return to port for another load.

Additionally, at shore bases throughout the Pacific, as the war progressed, there was large quantity food storage constructed. The naval base at Espiritu Santo was a major supply installation for most of the war. It ultimately had 24 very large refrigerated storehouses plus 5 provisioning warehouses for food supply to the fleets and shore installations. There were ten provisioning ships constantly operating out of Aukland, New Zealand, resupplying this facility and vessels at anchor in the bay (36).

Munitions

The constant requirement of war is munitions—munitions of many different kinds and sizes. War cannot be fought without them, so the logistics of munitions support becomes very critical and exceedingly complex. Consider, for example, some of the kinds of munitions involved:

- Shells.
- Powder.
- Bullets.
- Bombs.
- Torpedoes.
- Depth charges.

- Explosives.
- Incendiaries.
- Napalm.
- Chemicals.

And, all of these might be in dozens of different types and sizes. For example, shells might be:

- Armor-piercing.
- High-explosive.
- Incendiary.
- Concussion.
- Fragmentation.
- Chemical.
- Flashless.
- Tracer.
- Proximity fused.
- Instantaneous fused.

With all of this, we have merely scratched the surface of munitions needs, supply and maintenance. In addition to the initial supply of these war items, there is generally a reclamation process. Certain materiel needs to be conserved, and when practical, munitions might be collected through recycling. Recycling would be accomplished through return to the United States for salvage and reuse. For example, a US Navy cruiser after an assault might have tons of powder tanks and shell casings from 6- and 5-inch guns, shell cases from 200- and 40-millimeter guns, and so forth. They require pickup because the cruiser could not afford to keep them aboard for long and still have room to rearm. So another element of logistics was added to the requirements of war (37).

The Army was ruled by the maxim *munitions are expendable; men are not* (148:94). Accordingly, it used more artillery and ammunition than ever thought possible. There were 60 major types of artillery weapons that were more than .60 caliber. These ranged from the 2-millimeter automatic aircraft cannon to the 16-inch coast artillery gun. For the 20 different calibers of cannon, there were some 270 types and sizes of shells. The 105-millimeter howitzer, alone, used 25 different types of shells from high explosive with delayed action fuses to special concrete piercing projectiles.

There was no civilian industry on which to rely for munitions and artillery at the start of the war. The prewar Army had not used enough of these materials to warrant a continuing business. Therefore, all kinds of businesses were pressed into service to produce artillery and munitions. We used soap makers, bed spring manufacturers, soft drink makers, and so on. They did a fine job and produced huge quantities of very effective weapons and munitions. At the peak of production, there were 2,400 prime contractors and 20,000 subcontractors producing artillery. They built more than 600,000 complete cannons of all types and 200,000 spare gun tubes for replacements (148:94-6).

The rocket came into heavy play in World War II. The rocket launchers were relatively simple, but rocket ammunition presented special problems. The development was incomplete when the war ended, although the bazooka, an antitank weapon, was in great use by the infantry. The Marines also used it. Both Services found it useful in assaults and amphibious campaigns.

The Army found it needed to construct more than $3 billion worth of facilities for making explosives and smokeless powder and for the loading of shells and bombs. Twenty-five plants were built for loading, 21 plants for making high explosives and smokeless powder, and 12 for manufacturing the chemical components of explosives. All of these plants were operated under private contract. By war's end, they had produced more than 1 billion rounds of artillery ammunition and about 4.5 million tons of various types of bombs (148:96-7).

An example of the size of some of these facilities may be gained from a review of Ravenna Arsenal in Ohio. It began its activity in 1941 and, at a cost of more than $57 million, became the biggest munitions plant in the world. It had 1,200 buildings and employed 18,000 people. Explosives were stored in 500 earth-covered bunkers until they were shipped out to the Services. Women were in great demand for the work, particularly the shell-loading, because of their dexterity and small hands. An interesting sidenote: the female shell loaders could be readily identified in town because the exposure to the explosives in the shells turned their hair to a bright orange color (95).

Small arms ammunition requirements were truly astronomical. US Army troops in Europe were expending 293 million rounds of various small arms ammunition a month. The deliveries of .30-caliber ammunition reached 800 billion rounds in 1 month. The separate plants producing these small arms munitions reached a daily production rate of 71 million rounds. The scope of the munitions phase of military logistics in wartime should be clear (148:98).

Navy munitions were of equal magnitude. By late 1944, for example, the principal munitions storage for the South Pacific was the Munitions Depot, Espiritu Santo. It had in storage more than 38,000 tons of various kinds of ammunition in 175 magazines plus Quonset huts, wooden warehouses, open air storage, and thatched huts. Additionally, it had a major work force constantly engaged in overhauling and reconditioning ammunition, changing fuses, and the like. At the peak of its activity in 1944, it was servicing 120 vessels at all times (37:51).

Fire Fighting, Rescue, Salvage

A rarely thought of element of logistics is the fire-fighting, rescue, and salvage effort. The needs for this form of support exist in all military units no matter their mission. We have earlier noted the need for salvage of explosive casings, for example, but that is really one of the small aspects of this service.

It is easy to think of the need for fire-fighting capability if we consider our homes or places of work or recreation. Yet the need for fire fighting and rescue is as great or greater in aviation, armor, or on ships afloat. Think, for example, of the problems facing the crew and the passengers of a transport ship if fire erupts in the hold while in the middle of the Atlantic.

Or think of the problems if that transport is bombed and is dead in the water and burning. It is because of this likelihood the fire-fighting, rescue, and salvage crews earn their place in logistics.

Troops are bombed; aircraft crash; ships are bombed or torpedoed; buildings and bivouac areas are strafed; forward areas are shelled; vehicles hit mines; or crews run ships aground, taxi aircraft into each other, or run vehicles into head-on collision. All of these events usually require some form of fire fighting, rescue, or salvage. Generally, fire fighting is the first need, quickly followed by rescue and later supplemented by salvage, to hasten return to service or to aid in the decision to scrap. All of this requires special equipment, training, and preparation, and planning.

Fighting fire abroad *USS Langley* (CVL-27) after a kamikaze hit, off Formosa, 21 January 1945. *USS Ticonderoga* (CV-14) burns in the background. (Courtesy of National Archives)

The form of this support varies with the type of unit and the probable circumstances of exposure. In the Navy, each ship had fire-fighting and rescue gangs identified among the crew. They were provided special training and equipment and were responsible for the initial action following an incident or accident. But at times, the conditions would require support from nearby ships because the problem was too great for the ship's crew to handle alone. This was particularly true when the ship was in combat and had to continue its mission effort (for example, assault, offshore shelling, or aircraft launch/recovery) while trying to arrest a fire, make personnel rescue, or salvage an area (37).

Most salvage and repair for damaged Navy vessels came from support ships or shore facilities. The most plentiful were the fleet tugs that routinely handled fire, rescue, diving, salvage, reclamation, towing, and emergency repairs to ships of the fleet. They did a miraculous job in all instances.

Another phase of this effort, for the Navy, was the extremely important task of harbor clearance. When the Allies took over a harbor facility from the enemy, there were usually mines, barriers, and sunk vessels to clear away to make the harbor safe for use by Allied vessels. This was usually the task of trained salvage crews.

In the invasion of Italy, the enemy spent his last 3 weeks in possession of the harbor at Naples sabotaging the port. Hundreds of vessels and small craft were systematically sunk or disabled in strategic points to render the harbor useless. Many of these vessels were sunk by enemy salvage experts so our salvage people would have an extremely difficult time with them. Internal bulkheads were destroyed and hulls demolished in a manner to prevent their being pumped out and raised. Sometimes, locomotives had been sunk on top of small vessels. Munitions and explosives were haphazardly fused and dumped over the sunken wrecks. The Allied salvage crews cleared the port by massive lifting of wreckage or by dragging it to deeper water or indicated disposal sites. Within 3 weeks, 12 berths had been prepared for Allied shipping, and in 75 days, 30 berths were in use, more berthing than before the enemy actions in the harbor (36:313).

Medical Services

Medical services formed a standout element of logistics in World War II. The doctors, dentists, nurses, and corpsmen did a magnificent job and provided exceptionally good medical services. They faced many large problems in addition to the expected combat wounds. Some troops suffered from combat fatigue. Some flight crews contracted mission fatigue. The tropics presented debilitating skin fungus and fever ailments most doctors had only read about. There were peculiar fevers in the North African desert and in the China-Burma-India theater. The cold of the Arctic and the North Atlantic created special ailments and problems. However, the medical service worked its way through them all and provided outstanding overall support.

Deaths of servicemen and women from diseases were lower during World War II than in peacetime time and, surprisingly, lower than among similar age groups remaining in civilian life. The fatalities from combat wounds were approximately half those of World War I, due principally to the better medical services (148:121). Great gains were made in medical techniques, and many of them carried over into peacetime practices after the war. The medical services developed atabrine, which was used as a substitute for quinine for preventive treatment against malaria. They implemented the use of blood plasma and the wide use of whole blood for treatment of casualties. The laboratories developed sulfa drugs

and penicillin, which saved untold lives of combat wounded persons.

In the United States, there were general hospitals that served geographic areas. These were large facilities able to treat almost anything the troops brought to them. The Army alone had 60 of these large facilities. As the war progressed, these hospitals began to specialize, so that one might serve to treat burns, another respiratory ailments, and so forth. Each military station or base had a hospital equipped to handle most of the needs of that location. Patients beyond the care capabilities of the station hospital were evacuated to the general hospital serving the area. In addition, the general hospitals also accepted the injured and ill patients who had been evacuated for return to the United States (148).

In late 1944, a number of convalescent hospitals were established for patients who needed minimal attention, could do much on their own, yet who were not ready for discharge or for return to duty. These were less elaborate then the general hospitals and were basically minimal care facilities. Yet, they removed a large workload from the general hospitals and permitted them to concentrate on the more seriously ill. Sometimes when the patient was sufficiently advanced in this recovery, he was furloughed to his home for convalescence, again reducing the load on the medical services (119).

In the field, the individual units usually had access to a dispensary, which, as often as not, had no doctor but did have competent corpsmen. If the dispensary could not handle the patient's problem, the patient was moved to a battalion or regimental aid station. If beyond their capability, the patient went to the Mobile Army Surgical Hospital (MASH). The MASH enabled highly skilled surgeons to be concentrated near combat in order to provide rapid diagnosis and medical attention. (This was the beginning of the famous *MASH* that became a TV series years later.) Beyond that were the field hospital, general hospital, and evacuation hospital (148)

The small unit medical staffs were busy with sick call, inspections of messes and food storage facilities, supervision of mess kit cleaning (particularly overseas), and the administration of the recurring immunizations required for all military personnel. All of this paid off because, in the Army, from 1942 to 1945, there were only 12 cases of tetanus, resulting in a rate of 0.444 per 100,000 wounds and injuries. In World War I, this rate had been 30 times as high (159:94).

Similar provisions for medical care existed in the Marine Corps and the Navy. The Navy also provided the hospital ships that were noted for the large red cross painted on the hull. They provided exceptional care and saved many a life because of their expertise that was immediately available offshore when a sailor, marine, or soldier needed help.

As mentioned earlier, women played a big role in the medical services. They had historically been in the military services in the nursing field, but they did a truly outstanding job in World War II. The Japanese interned more than 80 of them, Army and Navy, as prisoners of war for 3-1/2 years. Many WAC and WAVES were also assigned to the medical facilities as clinic, ward, and laboratory technicians, and they also did an outstanding job.

Millions of servicemen and women were hospitalized during the war. The Army reported 15 million hospital admissions in the 1942-1945 period plus additional millions treated but not admitted. Approximately 1 million people were evacuated from overseas to hospitals in the United States. More than one-fourth of them were evacuated by air.

Hospital Ships

Hospital ships were provided by both the Army and the Navy, although the Navy had the greater number. These ships were generally painted white and were identified by large red crosses on the hulls and stacks. Even so, they were not free from attack by enemy submarines, particularly the Japanese.

The hospital ships were responsible for saving a great many lives. The wounded or ill could be given superb medical attention and treatment almost immediately after the need was established if the individual was located close to the shore. Hospital ship conditions for treatment were superior to the conditions ashore in almost every instance. The ships had two crews aboard: one to operate the ship and the other consisting of medical personnel—doctors, nurses, dentists, corpsmen, and specialists. They provided care and attention equal to or better than that in any part of the world and always close to combat.

Additionally, the crews worked hard to make the patient's life more pleasant. The ships provided movies, music, USO shows, and other forms of entertainment to ease anxiety and lighten the mental load of the patient. Special efforts were applied to meet holiday expectations. Appropriate meals and decorations were developed for holidays such as Easter, Thanksgiving, Christmas, and the Fourth of July.

Each ship had hospital wards formed to separate the patients according to their medical needs—surgery, medicine, dental, and the like. Each ship had operating rooms, intensive-care facilities, dental spaces, laboratories, and more. A hospital ship was very much like a large general hospital in its patient-handling facilities. Each could handle up to several hundred patients at a time. Often, they treated the patients only until they could be air-evacuated to a shore establishment in the United States. Each departing patient was usually replaced by a new patient. At times, the patients stayed aboard, and the ship sailed back to US or other major port where all the patients would be offloaded to shore facilities. The ship would then return empty to its zone of operations. The hospital ship was a principal element of medical logistics in World War II. Its personnel earned the accolades of thousands of patients whose lives were saved by their superb care.

In the invasion of Italy, the US Navy teamed with the British and Canadian navies to support the assault. Evacuation of wounded to the nearest hospital ship began within 14 hours of the initial landings. Medical care was provided immediately as decisions were made to evacuate, where necessary, to Allied hospitals in North Africa. Additional evacuation took place in LSTs, which were part of the invasion force.

Each LST had been prepared for this work with the assignment of one medical officer and two corpsmen in addition

to the one corpsman normally assigned the crew. Further, the LSTs were specially stocked with medical supplies including bandages, gauzes, dressings, gloves, needles, splints, syringes, tourniquets, sutures, and so on. In all, 59 specific medical items. Each LST also had 60 litters plus blankets and cots, dried human plasma, intravenous glucose, normal saline, and sterile distilled water. Medications included anesthetics, sulfa drugs, penicillin, tetanus toxoid, tetanus antitoxin, and the like. The low death rate from combat wounds is proof of the quality of medical care provided by all these elements (37).

USS Tranquility **(AH-14) arrives at Guam with survivors of the USS Indianapolis (CA-35), August 1945. (Courtesy of National Archives)**

Air Evacuation

Throughout the war, air evacuation of wounded and ill people was common. It is worth mentioning that the first helicopter evacuations took place in 1944. The Army Air Forces operated a special force, *Project 9*, in India in 1944 and 1945. They flew L-1 and L-5 aircraft for special warfare purposes and commando aid. They also had the new, relatively unproven, YR-4 helicopter, which had never been used for long-range flying or rescue service. However, one US and three British soldiers were down in Japanese territory in the jungle. There was no possible landing area for the L-1 or L-5 aircraft. The only help was the untried helicopter 500 miles away.

The helicopter was flown through the high-altitude mountainous terrain, landing every 100 miles to refuel from cans carried aboard in the cockpit. The helicopter made it successfully, and 2 days of rescue effort onsite were also successful. This was, to the best of knowledge, the first helicopter medical evacuation in military combat history (306).

The Home Front Logistics

Home front logistics encompassed far more that we can cover in this text. However, it is important that we understand the logistics relationships between the civilian world and the military world in our American society. The civilian world is dependent on the military for continued freedoms and ability to function. The military world is equally dependent on the civilian world for its ability to defend and protect our way of life and help our nation attain its national objectives. In this text, we will discuss only a small segment of the wartime home front logistics to establish relationships. We may not specifically call attention to a relationship but assume that it can and will be recognized by the reader.

Money and Prices

Military orders, initially from the British and French but soon to include the United States as well, began to feed the economic rebirth of our country in late 1939. As this happened and our security became more threatened, the country began to apply more and more money to national defense and to a number of other federal programs. This activity overcame the Great Depression, and our Gross National Product (GNP) began to grow. It jumped from approximately $90 billion in 1939 to more than $212 billion in 1945.

This growth was, cumulatively, greater than the accumulated spending on World War II or, for that matter, total federal spending. Because of this, the civilians at home lived a fairly decent life despite the war raging worldwide. They experienced only relatively minor disruptions in lifestyle from wartime controls and shortages. Certainly, there were controls and constraints. Certainly there were shortages of some goods and commodities. Certainly, there was the mental anxiety of relatives and friends involved in extremely hazardous duties around the globe. Despite these problems though, the civilian life was pretty good during the war.

Incomes rose slowly but continuously during the war. Consumer spending increased year by year even under the shortages and constraints. Foodstuff consumption, particularly meats, rose in spite of rationing. The residential use of energy (gas and electricity) also climbed annually. With this in mind, we can say the civilians on the home front lived an overall improving life and did it from the benefits of increased production with limited wartime reductions of goods and services (1:139-147).

With incomes and spending rising, even under wartime restrictions, the federal government began to worry about potential inflation. So, Congress passed new tax laws that

ultimately lowered minimum taxable income by 50 percent, making almost every American subject to income tax. To help control spending, income tax withholding was initiated and has become a way of life for Americans to this day. With these steps, the income tax became the source of about 75 percent of all federal revenue during the war.

Another effort to control spending was the war loan drives. These were under way continually. They urged people to save, not spend, by buying war bonds to be held for postwar income needs. The bond drives were very successful. They sold more than $43.5 billion to individual savers and many more billions of dollars to institutional savers such as insurance companies, banks, savings and loan companies, state and local governments, and other corporations (1).

We earlier discussed some of the federal programs and their effect upon military logistics. We must return to price control in relation to the home front money circumstances. Originally, the government hoped to control prices through voluntary, commodity-oriented price controls. The ceiling prices of these goods were announced by the government, but the government had no means to enforce the ceilings. All it could do, it seemed, was publicize the higher than ceiling prices of a company and threaten the company with the loss of future government contracts if it did not comply. Some did, but many did not. Loose as this was, it generally worked reasonably well until the war orders from Britain and France and the growing US orders heated up the economy and pushed industry to new production highs.

In January 1942, with the impetus of the US involvement in actual war, the President established the Office of Price Administration (OPA) as Congress passed the Emergency Price Control Act. This gave OPA power to freeze many retail prices and control rents in areas near military installations. The price base became the highest price of the item in the month of March 1942. This ruling covered manufacturers, retailers, wholesalers, renters and more. Food prices, though, were not controlled at this time unless they exceeded 110 percent of that designated parity.

All of this was workable, but there were problems:

- The OPA did not control wages. Other federal agencies did that. Wages could—and did—rise causing the costs to produce or manufacture items to also rise thus making price increases necessary.
- The March 1942 parity did not control new items. Therefore, a manufacturer could escape control by changing design or changing the style of a product, declaring it *new* and establishing a new price, uncontrolled at that moment.
- OPA could not—and did not—control quality. Prices, then, could be kept in the control range by lowering the product quality and its production costs. Essentially, of course, this meant a price increase eventually because the products did not last long and had to be replaced sooner than with fair quality. This quality degradation was never controlled.
- The posting of ceiling prices was not required by OPA, so the buyer did not always know if he was paying too much. An unscrupulous merchant very readily could price above the ceiling and get away with it for a long time. Some did.

So, price control was present but not very effective. Roosevelt, listening to his advisors, asked for and received the October 1942 Economic Stabilization Act enabling OPA to hold agricultural prices at parity, which was the highest price in the January-September 1942 period. Further, ceiling price posting was directed, and rents were frozen nationwide. These actions achieved an effective governmental control of the cost of living (1:140-2). The price controls also, of course, resulted in controlled prices for military goods that could be controlled under the program.

Agriculture

The agricultural industry of the country was at least as hard hit by the Depression as any other segment of American society. It was recovering but more slowly than industry when the Japanese attacked Pearl Harbor. Governmental controls in the 1930s had been directed to limiting production with the goal of raising farm prices. But with the war, the government reversed its position and now began to urge the farmer to produce more under controlled anti-inflation prices. The farmers responded, and production rose. So did agriculture prices in the 6 years between 1939 and 1945.

- Wheat and corn output rose by half a bushel each annually, but prices increased 220 percent over these years.
- Beef production increased by 125 percent while prices rose by 175 percent in these years.
- Hog production increased by 150 percent, and hog prices climbed by 230 percent in these years.

Rationing

In the late summer of 1941, the federal government was giving serious consideration to rationing and wondering how it could best be done. The British were rationing with what seemed to be great understanding of the people. Some business people in the United States, with shortages already becoming evident, were doing some self-imposed rationing by telling buyers they could only purchase a given quantity of certain commodities. Some grocers established their own rationing coupons for goods such as sugar and convinced their customers to abide by these cooperative limits. Some customers, of course, cheated by going from grocery to grocery to stock up. Other customers became angry about these forms of self-imposed rationing and would cease buying from a store. Some retailers rationed by telling customers they could buy shortage items only if they simultaneously purchased so many dollars worth of other goods. This, too, did not set well with many customers, and it was evident voluntary rationing likely would not function effectively (129:133-138).

While there were some shortages, rationing, when it did come, was more to control the economy than to control severe shortages. Many items were rationed during the war, but people generally did not suffer. If a person had a legitimate need for more than the ration allowance, the local rationing board could allocate additional quantities. The items rationed included, among others, tires, gasoline, fuel oil, sugar, shoes, coffee,

meats, butter, and many processed foods. In May, gasoline went to rationing in 17 coastal states at 3 gallons per week. It went nationwide in November that same year. Meats were recommended to be rationed starting in August 1942, but Roosevelt instead suggested everyone observe one meatless day per week. This was ineffective, and meats went on and off rationing throughout the war. Regardless, as we have stated, meat consumption went up during the war.

Rationing was effective, even though it was cursed and condemned by many citizens. It did limit consumption because the consumers could not buy more than their allocated quantity, for which they had a coupon unless they went on the black market to buy additional coupons or the commodity and probably paid premium prices. These consumption limitations reduced demand, of course and, surprisingly, helped control prices as well. Further though, and probably of greater overall importance, the reduced consumption also reduced the needs for transportation and fuel (1:142).

Rationing was administered by coupons or stamps, which came in books for most items. Distinctive coupons were used for shoes and petroleum products. Special certificates of allowance were required for bicycles and typewriters, among other such goods. The paperwork of rationing was massive. In fiscal year 1943, alone, for example, it required 44 million pounds of paper products (129:138).

Rationing control was in the hands of ration boards locally established but manned by volunteers. The boards gradually assumed control over all rationed products although they originally began only for tires. All in all, they did an excellent job, and the volunteers were never replaced by an official government bureaucracy (129:136).

Labor

Earlier in this chapter, we mentioned the surge of patriotism following the Japanese attack on Pearl Harbor and the Philippines. The surge caused labor leaders to vow *No Strikes*. That was not a long-lived vow, unfortunately.

Unions had become increasingly militant throughout the 1920s and 1930s. As the economy improved with weapons orders, union memberships climbed to new levels. For various reasons, there were about 4,000 strikes of varying lengths in 1941, which cost the nation 23 million man-days of work (1:143).

In December 1941, the President established the National War Labor Board (NWLB) to help avoid work stoppages in defense industries. The NWLB set wage guides and attained labor-management agreements in a number of conditions. The actions did not prevent strikes, however. The strike experience and cost were as follows:

- 1942 3,000 strikes 4.2 million man-days.
- 1943 3,700 strikes 13.5 million man-days.
- 1944 5,000 strikes 8.7 million man-days.
- 1945 4,700 strikes 38.0 million man-days (1:144).

The NWLB played games with wage controls. The board readily approved reclassification of jobs so that, given a new title, a person could be paid more doing the same job. Or the board agreed with the idea of management paying for travel time and fringe benefit increases as increased compensation without wage increases. Even with all this and all the work stoppages, labor did produce the needed weapons and supplies for our ultimate victory over the Axis Powers and Japan.

Demobilization

When the war ended in Europe, we still had to consider the needs of the war in the Pacific against Japan. The plans for that remaining war called for a two-phase assault on Japan. Phase 1, called *Olympic*, required an invasion of southern Kyushu beginning 1 November 1945. Phase 2, called *Coronet*, required an invasion of the Kanto plain near Tokyo beginning 1 March 1946 (119, 225). The planning estimates included the use of the rest of 1946 to probably end the war and from a half a million to a million US casualties plus those of our United Kingdom Allies, all in addition to the losses of Japanese military and civilian personnel. By the middle of May, the redeployment of troops from Europe had begun. They were processed back through the United States for leave and then would move on to the Pacific. As many as 1.5 million had been discharged because of their long combat service in Europe and the desire of our country's leaders not to cause them to put up with more (119:560).

Through all of this, Twentieth Air Force B-29s had been flying fire-bombing raids over Japan and had destroyed great portions of the principal cites of Japan. Japan's industrial capability had been greatly reduced through these raids and by the absence of oil and other materiel no longer able to get through our naval blockade. On 6 August, the first atomic bomb was dropped on Hiroshima, with tremendous loss of life and physical destruction. On 9 August, Russia entered the war against Japan, and on that same day, the United States dropped the second atomic bomb on Nagasaki, this, too, with tremendous loss of life and physical destruction.

Japan had, through this time, been tentatively feeling out the United States for ways to end the war *honorably,* but the United States and its Allies would agree to nothing short of unconditional surrender. Finally, the United States agreed to permit the Emperor to remain as the titular head of the government. On 15 August 1945, the Emperor spoke to the Japanese people and told them the war was ended. This was V-J day and welcomed around the world. The final surrender ceremonies aboard the *USS Missouri* on 2 September were anticlimactic but ended the war (225). Officially, however, the war against Japan actually did not end until the peace treaty became effective 28 April 1952.

The war was over, but we faced the problem of demobilizing our forces now in position all over the world and demobilizing the American industrial base that had performed so gloriously during the war. Demobilization planning had begun in 1943 when it seemed we were sure to win the war, but there were no official policies for this action. Officialdom seemed intent on not making such policy. This confused those responsible for actual demobilization and caused some hectic actions that were neither required nor economically sound.

When the war ended, there were approximately 12 million people in the Services, located at hundreds of sites in all areas of the globe. Plans for release of those in the military had been made. Release and discharge were to be based on *points*. Each person in uniform had calculated for him or her, a point total based on length of service, service overseas, combat service, and parenthood. This was called the Adjusted Service Rating, and it was calculated twice. The first was on 8 May 1945 following V-E Day and the second on 2 September following V-J Day. Those with the highest number of points were theoretically scheduled to be returned home first. Orders caught troops en route from the European theater and turned them around often without regard to their *points,* and the breakdown of the planning began (148:216-220).

A phenomenon known as *Mom-ism* set in—the troops had to be brought home and released so they could get back to their mothers, wives, sisters, and girlfriends. The idea was to do that immediately. The Services tried, but the constraint was ocean and air transport. No matter how hard they tried, there were delays, and this caused more dissatisfaction. The return of service personnel became the priority mission for 550 ships, ranging from battleships to aircraft carriers to Victory ships. The orders were to draw down to only essential occupation forces and start all others home. Military brides (35,000 plus 15,000 children from the United Kingdom alone) added to the transportation problem. Between 1 September 1945 and 31 May 1946, more than 9 million were released from the Services (223, 118:35). This was disaster for the supply and maintenance forces, because in most instances, they had no one left to do essential jobs. The mission capability of the world's mightiest military force came suddenly to an end.

The sudden end of the war caught the United States with no plans for what to do with the types and quantities of supplies and equipment on hand. There was no answer to the question, Should we return any of this materiel to the United States? If so, which and how much? The rapid loss of people in the mass discharge actions left practically no one to handle these supplies and equipment. As a result, much of it was abandoned by the troops as they closed up shop to return home. Some destroyed their equipment by driving it over cliffs or sinking it in harbors. Not all of this was undirected, of course. The Services recognized the problem and tried to issue proper directions but could not prevent massive losses. They did arrange to transfer much military equipment and supplies to foreign governments and to donate some to schools and laboratories in the United States. It was estimated there was in excess of $50 billion in supplies and equipment in overseas units in August 1945 plus that which was in the US posts, camps, and stations (119:563).

So far as it was possible, the Services stopped overseas shipments with war's end, except for foodstuffs and medical supplies. Other materiel and items were stopped en route or at the ports and further shipped only with verification of essential need. Regardless of this action, the pipeline was full on V-J Day, and there were millions of items and billions of dollars flowing that could not be readily halted. Where they could be and where the manpower permitted, these items were demilitarized, if necessary and offered in surplus sales. Many a new business was begun with this sale materiel, and many an older business was rejuvenated by it.

In the United States, the end of the war brought immediate action to halt war contracts and begin termination settlements. The procurement people had been preparing for this and had pre-prepared telegrams ready for dispatch when the official word of the end of the war was received. This kind of action had been going on all through the war, of course, as contract needs changed. The speed and enormity of this final action was the difference. Within a year, the contracts of World War II were virtually all terminated without major problems for the courts (148:292, 119:568).

Lend-lease was terminated on 20 August 1945, and provisions were made to purchase the materiel in the lend-lease pipeline if they had the cash or could arrange for suitable credit. But for practical purposes, the great effort to keep our Allies functioning now stopped, and they were on their own until other programs began.

Repatriation of the war dead had begun in small scale with the beginning of the war. During the war, there was not much return of the bodies to the United States because we did not have the manpower or shipping to handle it. Now, though, with the war ended, a full-scale repatriation of war dead could begin. By the middle of 1949, more than 150,000 dead had been returned to the United States for reburial. Many of the war dead, though, remained in their overseas cemeteries or their place of death, as is the case with the *USS Arizona* at Pearl Harbor and the American cemeteries of Europe and the Pacific. Approximately one-third of the families responding to War Department letters about the burial of war dead chose repatriation of the body (119:562, 148:238).

The war was ended. The troops of all Services were home or en route home. The mighty US military machine sputtered to a halt as 1945 ended. The war could now become a memory and an event for historians to work.

Logistics Lessons to Be Learned

The logistics experience of World War II should teach us something. The few words that follow provide an abbreviated version of the major ideas that should come from the experience.

- No decisions in modern warfare are free of logistics considerations. The logistician must be involved in all planning for defensive or aggressive use of forces.
- Strategy, tactics, and logistics are inseparable parts of the same military capability system. None of the three can be omitted or avoided without suffering possible future costs for creating and sustaining military capability.
- Most warfare of the future will require coordinated land, sea, and air forces working in cooperation toward a common goal. Therefore, it is extremely important that we ensure at all times the inclusion of the three in joint planning and keep each other advised of independent actions. We should

also consider advance designation of who will command what in event of war so logistics may be operated jointly, intelligently, and effectively, without confusion, delay, or duplication.

- A truth often overlooked is that we do not have unlimited resources. All that we need for military capability is somehow restricted and must be considered in that light. We will need some effective form of national allocation of essential resources.
- The first goal of an enemy will probably be to destroy our logistics infrastructure and our potential for creating and sustaining military capability. Therefore, we must provide protection for key logistics areas and ensure redundancy of sources and deliveries.
- We will not likely have the luxury of time in which to get ready for the next war. It will likely be fought with what we have when it starts. If it is a certain type of war, we may then have no backup industrial support to count on.
- We cannot allow ourselves to think we will take care of that when it happens because we probably will not be able to do that. The next war will likely provide us no time for correction of long-lived omissions and errors. We must plan and act now to ensure readiness at all times. We must constantly exercise to ensure we have the ability to immediately respond. Any delays in getting the logistics machinery working may be fatal to our country and our way of life.
- We must urge and encourage the national authorities to relocate those logistics planning bodies needed for all-out warfare and keep those bodies functioning and actively ready for that war should it come.
- World War II showed us the country needed to control the economy—and many facets of daily life—to mobilize for war. In that war, it took a long time and wasted a lot of effort. Such should not happen again. We must be ready to act immediately.
- Much of the world's resources may be denied us just before, or early, in the next war, thus destroying our capability to employ essential and critical materiel. Modern technology will demand the use much of this. Therefore, we must initiate and maintain an active strategic stockpile program to provide our critical resource needs. We absolutely must have minimum requirements on hand in reserve for war use.
- We must initiate and maintain active, cooperative mobilization planning with all elements of the national economy, including all those facets of the national logistics infrastructure.
- We must create and teach logistics doctrine that is dedicated to successful warfighting. Peacetime professional military education must include equal quantities of strategic, tactical, and logistical content in the curriculum. All military officers must learn the logistics system so they know its limitations and capabilities.
- Research and development for new and improved weaponry is essential. It must be considered part of the logistics system and always be adequately funded and supported. We cannot afford to be bested in technology by an aggressor nation more willing to pay for research and development in peacetime.

US Strategic Bombing Survey

The US Strategic Bombing Survey following World War II did not fully support the longheld claims of the Army Air Corps and the Army Air Forces that air alone could win a war. The survey did not show that to be the case in World War II in either Europe or Japan. But the conditions found in Japan at surrender more closely fit the earlier claims than did those in Europe. The report did indicate that bombing was important when it was directed against significant elements of the enemy's warfighting capability. While the report did not specifically identify *logistics,* the findings do show that destruction of an enemy's key logistics elements may be crucial. For example, the report indicated the following about the effects of bombing Germany.

After 2.5 years of RAF and US strategic bombing of war production targets:

- Germany's military output of aircraft and munitions rose by threefold, and output of tanks increased sixfold.
- There was no evidence that shortages of civilian goods ever required the transfer of resources from war production to prevent homefront disintegration.
- Civilian morale remained high, considering their belief in ultimate victory and confidence in their leaders declined.
- The civilian populace continued to work effectively as long as the physical means of production remained.
- Attacks on transportation were decisive blows that completely disorganized the Germany economy.
- Transport proved the weakest link in Germany's logistics chain. Its failure was the immediate cause of the breakdown of the supply system and, consequently, was the decisive factor in the collapse of the German Army (334, 335)

Thus, with no further elaboration, we may see the effect of transportation failure in wartime military logistics. It is worthwhile for us as logisticians to worry about the state of our worldwide transportation system and its probable wartime capability requirements. Is it adequately protected in all its modes? Have we adequate transportation? Are we ensuring we have the correct modes and capacities constantly available?

Have we an effective rail system? Is our merchant shipping adequate? Is our airlift adequate? Do we have mobile port and cargo-handling systems, equipment, and personnel ready for immediate deployment? Are we ready for onsite airfield construction and operation?

The possible questions are many. This final entry in our survey of World War II is merely intended to give the military logistician an urge to ensure wartime capability in planning. Certainly, this should be one of the major lessons to be learned from the hectic, terrible, and expensive experiences in World War II.

Chapter Three

The Postwar Period

The time from the end of World War II to the beginning of the Korean action in 1950 was 5 years of confusion and mixed effort for military logistics. Immediately following the war, the principal logistics problems were those of demobilization, occupation forces, and regaining military capability. All of this was going on simultaneously with growing concern for the strength, intentions, and actions of the Soviet Union and its chain of sympathetic countries. While we were undergoing an almost total collapse of the world's greatest military machine, the Soviets were holding their forces and returning to peacetime activities much more slowly.

In retrospect, it seems rather obvious the USSR did not intend to lose the military strength and capability it had built up during the war. It had no intention of allowing its citizens to return to a life of peacetime without strong military forces to support its international aims. This created many problems and led to the era of the Cold War during which the world sweated actions by the two major powers, always afraid one would nudge the other into doing something that would again ignite the fires of war.

Our hasty demobilization actions bled our military of most of its capability. The few remaining logistics forces were busier than ever trying to transport home those military people due for release from service, take care of all the excess and surplus property around the world, and yet retain some form of military capability to protect US interests in the occupied territories and the rest of the world. It did not work very well.

The discharge of close to 9 million men, almost overnight it seems, left the Services with many chiefs and few Indians. Most of those who remained in service in late 1945 and early 1946 were officers and senior noncommissioned officers. Military capability suffered. These higher ranking people were forced by circumstances to perform jobs they were not qualified to perform.

For example, in the Army Air Forces, at some bases, officers were turned to duty as aircraft and engine mechanics making periodic inspections on B-29 and other aircraft. Very often it was then necessary to route an aircraft completed by the officers through a work station manned by NCOs to ensure the work had been properly and safely accomplished. Thus, flight schedules lost all sense of reality, and readiness dropped to bottom (183). In March 1946, only the Navy indicated capability for even limited military action, yet the affairs of the world were demanding more military strength from the United States than was available.

It was generally, but not unanimously, agreed that the major lesson coming out of World War II was the development of airpower as the predominant military force of the future. As conditions occurred, airpower seemed the only potent force since we did have long-range bombardment aircraft and the atomic bomb. There was growing concern about the Russians and their allies because of actions and statements in Europe and other parts of the world. As a step toward improving our military ability to respond to world threats and take advantage of what little we had left from World War II, the United States established the Strategic Air Command (SAC), Tactical Air Command (TAC), and Air Defense Command on 21 March 1946.

The Eberstadt Report—1945

In mid-1945, James Forrestal, Secretary of the Navy, asked Ferdinand Eberstadt, who had been very effective in national war efforts, to explore the subject of unification of the War and Navy Departments. Mr Eberstadt's report was published 22 October 1945 by the Congress as a publication of the Committee on Naval Affairs, US Senate (241). The report has great logistics and historical value, although it seemed to have minimal impact.

The report defined logistics as follows:

> The term "procurement and logistics" as used in this chapter means the complete process of the planning, procurement, distribution, and the supply of personnel, materiel, and facilities to establish and maintain military force (241:101).

Among the many points made in the report were the following:

- Logistics has assumed increasing importance from war to war. It has been complicated by constant changes in the nature of military operations, the increasing size of forces employed in warfare, the increasing range and intensity of military operations and the shift from personal combat to mechanized combat.
- Logistics has four predominant phases, which might be identified as:

  Determination of requirements.
  Procurement of materiel.
  Provision for production facilities.
  Distribution of materiel and personnel.

The degree of coordination in military logistics of the Services, he said, is limited by several factors, which are:

- Differences between the tactical missions of the Services that controlled the required logistics support.
- Naval warfare is different from land warfare in detained objectives, weapons, and the characteristics of the domain in which it is waged.
- Naval support demands flexibility far greater than that for *fixed* ground activity.
- The logistics organizations, philosophies, and control procedures in the Services differed.

Mr Eberstadt suggested our postwar military organization should aim to preserve the strengths and remedy the weaknesses disclosed in World War II. His general conclusion was that unification of the Services was not then advisable (241:42). The factors of World War II that he recommended be observed for any planned military reorganization included the following:

- Strategic planning and operational execution were good.
- The background of cooperation between the Services was satisfactory.
- All the military services alike contributed to winning the war.
- There was no civilian interference with war plans.
- Congress supported the war effort.
- The nation was unprepared for war.
- The initial military program was very limited.
- Our foreign and military policy were not closely related.
- There were gaps between strategic plans and their materiel implementation.
- Relations with scientific research and development were not adequate.
- Intelligence was not effectively handled.
- We did not have adequate stockpiles of strategic materiel.
- Weaknesses occurred in civilian mobilization.
- There were serious defects in procurement and logistics.
- Weaknesses existed in military education and training.
- The general conclusion was there were serious weaknesses in coordination (241:23-30).

Each of these topics would be interesting to pursue, but this text is not the place for that. It is proper, though, for us to recall that inadequate coordination has been mentioned a number of times as we discussed World War II. Communication, coordination, and cooperation certainly seemed to be the principal elements of effective logistics, and they should be stressed at every opportunity. Their inadequacies in World War II have been noted, and the costs of their failures should be clear.

The National Defense Environment

The national program for defense that gradually evolved was based on relatively low budgets and a military force of no more than 2 million men backed by a strong and ready Reserve and National Guard structure and supported by Universal Military Training (UMT) of 1-year duration for all male citizens. However, while the low budgets came to be fact, UMT did not. The anticipated strong support backing up a relatively small active military forced did not take place.

Many military personnel were engaged in occupation duties. The maintenance of the military government structure, support of the emerging civilian economies of the conquered nations, and support of our overseas military forces became the prime logistics job. It was necessary to maintain a continuing flow of essential supplies (food, medicines, and spare parts) to keep our forces functioning and to assist the people of the occupied lands. In March 1947, the President announced the Truman Doctrine aimed at providing aid to Greece and Turkey. The doctrine also stated the US intention to halt further Russian inroads in noncommunist Europe. In June that year, the Marshal Plan began providing supplies and support for the conquered nations and our Allies to recover their economic strength. These actions increased the pressures on the logistics structures of our country and, in particular, the military logistics systems.

The National Security Act—1947

On 26 July 1947, the National Security Act was signed. On 18 September, it became effective, and the National Military Establishment (NME) was created, headed by the Secretary of Defense. Three military departments—Army, Navy, and Air Force—were created with the secretary of each and the Secretary of Defense having cabinet status. The first Secretary of Defense was James Forrestal, who had previously been Secretary of the Navy. The Navy had opposed unification of the Services primarily because it thought it would lose much of its traditional aviation to the new Air Force and its Marine Corps to the Army. In addition, it wanted a part of the strategic air mission, which the act did not provide. The Army and the Air Force had generally pushed for unification and supported the new law. President Truman believed in unification, pushed for it, and won over the Congress.

The act sought to preserve and develop the better parts of the independent Services while concurrently providing unified control and direction. However, the act did not provide the Secretary of Defense with much authority but left him more or less in a coordinating role. With a long history of Service competition and rivalry and unsettled major differences, the Secretary was sorely handicapped.

Three new functions came with the act, and a fourth was continued from World War II. The continuation was the Joint Chiefs of Staff (JCS), which would consist of the Chief of Naval Operations and the Chiefs of Staff of the Army and the Air Force. The law limited the staff of the JCS to 100 officers in an effort to avoid the creation of a general staff corps. The three new functions were the National Security Council (NSC), which was designed to advise the President on the integration of military, domestic, and foreign policies; the Central

Intelligence Agency (CIA), which took over from the National Intelligence Agency and was designed to coordinate all government intelligence activities and report to the NSC; and the National Security Resources Board, which was designed to advise the President and coordinate, military, industrial, and civilian mobilization. All of these functions have continued until today except the latter, which has gradually been absorbed into other federal agencies (119:579-580).

The Hoover Commission

The Hoover Commission was initiated in 1947 by Public Law 162. The commission was titled *The Commission on Organization of the Executive Branch of the Government*. To assist it in carrying out its duties, the commission appointed a number of task forces to study specific areas of the executive functions and activities. One was *The Committee on the National Security Organization* headed by Ferdinand Eberstadt, who had been Chairman, Army Munitions Board and Vice Chairman, War Production Board, in World War II. He had also conducted the unification study referred to earlier in this chapter. This committee submitted its report on 15 November 1948, and ex-President Hoover sent it to Congress on 13 January 1949 with a reminder that the committee's report was not the commission's report, all the recommendations were not accepted, and a commission report on the National Security Organization would be submitted separately.

The committee had many famous people on its staff and as consultants; for example, Chester Barnard, president of the Rockefeller Foundation; Hanson Baldwin, famed military writer, *The New York Times*; Robert Patterson, Under Secretary of War (World War II); General Robert Wood, chairman of the board, Sears, Roebuck, and Company; Lieutenant General James Doolittle, vice president, Hughes Tool Company; Admiral Ben Moreel, president, Jones and Laughlin Steel Company; Admiral John Towers, vice president, Pan American Airways; General of the Army Dwight D. Eisenhower, president, Columbia University; Fleet Admiral Ernest J. King, Washington; Fleet Admiral Chester W. Nimitz, San Francisco; General Carl Spaatz, Washington; Charles Wilson, president, General Electric Company; and Oveta Culp Hobby, executive vice president, *The Houston Post*.

The report showed the National Security Organization was headed by the President of the United States, who was served by three key staff elements:

- The Secretary of Defense.
- The National Security Council.
- The National Security Resources Board.

The National Security Resources Board had no subordinate elements. The National Security Council had one subordinate element, the Central Intelligence Agency.

The Secretary of Defense headed the National Military Establishment (NME). (You should note that the Department of Defense did not come to exist until later.) For the report, the elements under the Secretary of Defense were collectively identified as the National Military Establishment. The Secretary had seven subordinate elements, which were the:

- Joint Chiefs of Staff (and the Joint Staff).
- War Council.
- Munitions Board.
- Research and Development Board.
- Department of the Army.
- Department of the Navy.
- Department of the Air Force.

Each of the three primary staff elements and subordinate elements had a specific mission and a list of specific duties stemming from the National Security Act of 1947. But in brief, the public business entrusted to the National Security Organization was to:

- Plan for and provide adequate national security (political, military, and economic).
- Develop sound and practical measures against present and future contingencies.
- Do this at minimum cost but on a sufficient scale.
- Do this with full military efficiency but under civilian control.

However, the committee acknowledged these tasks were difficult to do. It said the completely efficient security system would not be economical, and the completely economical security system would not be militarily efficient. Further, there was no such thing as *absolute* security, and no national security system could certainly and completely fulfill the ideal requirements. At best, it could achieve an approximation of them.

For the accomplishment of its responsibilities, the committee adopted the following basic criteria:

- The primary objective of the National Security Organization is to preserve the peace, but it must at all times be ready and able, promptly and effectively, to marshal all of our resources, human and materiel, for the protection of our national security.
- Civilian influence must be dominant in the formulation of national policy, and civilian control of the National Military Establishment must be clearly established and firmly maintained.
- The nation is entitled to the maximum possible return for every dollar of military expenditure.
- Military efficiency—in other words, readiness for war—must be the fundamental objective of the National Military Establishment.
- Elimination of wasteful duplication is essential to good government, but the preservation, within sound limits, of a healthy competitive spirit and of service pride and tradition are basic to progress and morale.

Based upon and judged by these criteria, the Committee reported it believed the National Security Organization,

established by the National Security Act of 1947, was, on the whole, soundly constructed but not working well. (It should be noted that a later comment in the report indicated that the committee believed the National Security Organization was *improving*.) However, the committee expressed concern about the cost of the military establishment, which, for fiscal year 1949, was about $15 billion. This, they said, seemed unduly high in terms of both the ability of the economy to sustain and the actual return in military strength and effective national security.

In relating to the stated concern about cost, the committee indicated the following as probable causes for high cost:

- The National Military Establishment is young, being only 1-year old, and thus lacks experience, procedures, and skilled people.
- The lack of clear, firm policy from above.
- Failure to fully understand the National Security Organization and use it to the extent of its potential.
- Continuance of intense interservice rivalries hampers and confuses sound policy at many points. One of our greatest needs is to elevate military thinking to a plane above individual service aims and ambitions.
- Inadequate liaison between foreign policy and national military power.
- Disturbing inadequacies in our intelligence system.
- Authority within the National Military Establishment should rest with and in the Secretary of Defense.
- Insufficient sense of cost consciousness in the military establishment and lack of a general realization of the vital importance of utmost conservation of resources to national security.
- Urgent need for better fiscal policies and closer inventory control throughout the NME.
- Lack of preparation for new and unconventional methods of warfare.

Reiterating its concern with costs, the committee expressed its feelings thusly:

> The most disturbing aspect of the National Security Organization as it now stands is the enormous cost of the National Military Establishment. In the year preceding the First World War, the military establishment cost the country $2.25 per capita. In 1938, before the Second World War, it cost $8 per capita. For the current fiscal year the per capita cost has increased to $100,000.

The committee offered six major areas needing improvement.

- Strengthen the central authority in the National Military Establishment.
- Overhaul the military budget.
- Improve teamwork throughout the National Security Organization.
- Relate scientific research and development more closely to strategic planning.
- Expedite plans for civilian (economic, industrial, manpower) mobilization in case of war and provide for continuous appraisal of the effect of all national security programs on our national resources, human and materiel.
- Make adequate provisions for and against new and unconventional means of warfare.

The committee had considered and rejected three major concerns. The rejections were *not* unanimous, and there were some strong opinions about each. The three rejected concerns were:

- A single military chief of staff over all three Services.
- Merging the three military departments into a single department.
- Merging the naval air arm with the Air Force.

Conclusions

The general conclusions of the committee were:

- The National Security Organization meets an essential need.
- National security is a continuing problem.
- Military strength is only one element of national security.
- The National Security Act provides the basis for a comprehensive national security program.
- The basic concept of the National Security Act is sound (62).

It should be noted that much of this stated concern became the concern of others, and the NME became the Department of Defense, and the central authority was strengthened considerably by revisions to the National Security Act of 1947.

National Defense

The shortcomings of the 1947 act caused great worry to many people, principally the Secretary of Defense, and created a number of recommendations for change. An amendment was enacted in 1949 by which the National Military Establishment became the Department of Defense and the recognized authority over the three military departments. The Secretary of Defense retained cabinet status, but the three departmental secretaries lost such status and became subordinate to the Secretary of Defense. Further, the DoD gained control over the total defense budget and thus gained considerably more authority over the separate actions and intents of the Services. The position of Chairman and the Joint Chiefs of Staff were created, and the staff for the JCS was increased to 210 officers. This proved adequate and, while again slightly altered by an act of 1958, was the structure operated to 1986 (119:579-581).

Over all of this was a growing concern about logistics. Low budgets and deteriorating equipment were leading to less and less military capability. In July 1948, the Naval Air Transport Service and the Air Transport Command were merged to form the Military Air Transport Service (MATS) operated

by the Air Force. For awhile, naval equipment and aircrews operated under Air Force control as functional parts of MATS, but ultimately, the command became completely Air Force. Later that year, the Army relinquished its troop transport operation to the Navy, which formed and operated the Military Sea Transportation Service (MSTS).

In November 1949, in reaction to a series of arguments and findings of duplicative supply services, the Secretary of Defense directed each department to man and operate a supply system. This was followed by agreements between the Services about who would stock what, but it was left to later decision to solve the really knotty problems of supply of common items (119:583).

In August 1961, the Defense Supply Agency (DSA) was created. This action, pushed to a large extent by outside sources, was a reaction by the DoD to clamors for economy and rationality in the procuring of supplies common to two or more Services. It was thought to be more economical and wiser to consolidate the process of procuring these common commercial items through a centralized supply function rather than having the departments obtain their own needs often in competition with each other (235:152-4). Earlier defense action had begun the establishment of single managers from the Army and Navy (the Air Force was assigned none) for the purchase and management of commodity classes such as food, petroleum, clothing, and medical supplies.

Air Force Aircraft Maintenance

Meantime, in the Air Force, the tightening budgets and manpower constraints, plus mission changes, led to the deactivation of all the Air Force overseas depots and the reduction of the US depots ultimately to five beginning in 1953. Maintenance of Air Force aircraft was done by four separate systems or combinations of systems, according to the major air command demands. These four systems were as follows:

- **Crew Chief System**. A crew chief was responsible for all the maintenance performed on his aircraft. He and his crew (if others were assigned) did most of the work of the organizational level including periodic inspections. However, specialists from base shops assisted them when needed. The difficulty with this system was that it demanded an experienced and highly competent crew chief. That kind of person was not always available, and maintenance, therefore, suffered.
- **Production-Line Maintenance System**. Crews of mechanics specialized in doing certain phases of periodic inspections. They worked at fixed sites with mobile workstands and platforms. The aircraft was towed or pushed through the stations where the specialized crews did their work before the aircraft moved to the next station, somewhat like an automobile assembly plant. The crew chief accompanied his aircraft always. A similar approach was used for the complex tasks of building up an engine for installation on an aircraft—the engine moved down a production line while specific tasks were done by people working in fixed work stations. The problems with this system were its manpower needs, super-specialization and facility requirements.
- **Dock System**. A special workstand arrangement, called a dock, was located in a fixed position and fitted with power, air, and other resources. An aircraft was towed or moved into the dock and stayed there until the work was finished. Specialist crews assigned to the dock or to supporting shops came to the dock to do specified tasks aiding the dock crew. All work was accomplished under the supervision of the dock chief. The crew chief gave up his control of the aircraft while it was undergoing dock work. The problems with this system were its facility requirements, scheduling, and specialist needs.
- **Specialized Inspection System**. Aircraft were inspected and maintained under highly specialized conditions. The aircraft remained at a fixed site and was visited by specialized crews for specific tasks at specific times for scheduled periods of access. The system demanded close scheduling, careful time control, high degrees of specialization, and good transportation support. These were also its major problems.

In the spring of 1949, General LeMay, Commander, Strategic Air Command, assembled a small group of maintenance officers to develop a new approach to aircraft maintenance for SAC. He was gravely concerned about the low reliability of the command's aircraft, low readiness, and poor flight performance. The group used the specialized maintenance experience of the XX Bomber Command in the Marianas in World War II as a base. It developed the SAC specialized aircraft maintenance system, which was published in SAC Regulation 66-12 in August 1949 (183).

The SAC specialized aircraft maintenance system established centralized control of maintenance through a chief of maintenance, who managed and directed all maintenance functions of the wing. Maintenance Control planned and scheduled work, coordinated flight schedules with operations, and provided overall direction to the maintenance complex. Squadrons were specialized. The bomb squadrons did flight-line maintenance and, through maintenance control, requested assistance of specialists from field maintenance or armament-electronics maintenance squadrons. One squadron was established to man and operate inspection docks, calling on the shops for specialist assistance. All maintenance efforts were scheduled by maintenance control.

The system met much resistance from operational commanders and maintenance personnel. Most of the resistance stemmed from the belief, which had been created before and during World War II, squadrons should be small, self-sufficient, and responsible for their own logistics and tactics. They failed to see this could not be in the more complex times with leaner budgets, constrained manpower, and more sophisticated aircraft. It took much harsh action by senior commanders to force the system into being and make it work over all this dissension. But it did work, and slowly the

reliability of the aircraft improved, readiness climbed, flight schedules were met, aborts declined, and pride in a job well done could again be felt. It was successful, although it must be admitted it cost the sense of ownership and closeness existing with the older crew chief system.

In the summer of 1956, a representative of SAC and a representative of the Air Materiel Command (AMC) (which later, in 1961, became the Air Force Logistics Command) rewrote the SAC specialized maintenance manual for Headquarters USAF. It was published in September 1956 as Air Force Manual 66-1 and declared optional for major command use. US Air Forces in Europe adopted the manual, and SAC adopted it finally after much soul-searching. Republished in July 1958, AFM 66-1 became mandatory for aircraft maintenance throughout the Air Force. It soon became the requirement for other maintenance as well.

Air Force Logistics and Research and Development

Growing concern was being expressed about the lack of maintainability considerations in the procurement of weapons systems. Additionally, the reliability of systems, subsystems, and components was under question. This led to a review of the research and development efforts of the aviation forces and the procurement and supply support of those forces. The following is the history of actions in these areas.

In 1917, the Army Signal Corps (which was the parent of the Air Service and the Air Corps) had a science and research division at McCook Field, Dayton, Ohio. The division had two sections. One was for research and development while the other was for production. When a new item was fully designed, the Research and Development (R&D) Section passed responsibility to the Production Section. However, the R&D work was done in isolation, and there was no assurance what had been designed could, in fact, be produced. There was considerable disagreement caused by this and agitation for combination of the functions.

Nothing was done though, and in the 1920s and 1930s, because of the growth of aviation, companies did their own development and offered unsolicited proposals to the Air Service/Air Corps. This greatly reduced the need for an active Army aviation R&D function, and emphasis turned to development because the low budgets of the time allowed very little procurement. Most of the R&D effort went to remedy defects in the few machines on hand. Most R&D work was contracted to colleges and corporations, and this continued for most of World War II.

During World War II, the Army Air Forces organized two special commands to support the logistics needs of the war. One was the Air Service Command (ASC), which was responsible for the distribution of supplies and aircraft maintenance. The other was the Air Materiel Command , which was responsible for research and development plus the procurement of aircraft and their accessories. When spare parts were required, ASC determined requirements and initiated procurement action. AMC actually did the procuring after the ASC initiation. However, ASC had to follow up on orders to ensure supply to the forces in the field. Very often, this crossed the responsibility lines of AMC and created conflict, resentment, hostility, and confusion. None of this was desirable for war support, so on 1 September 1944, the two commands were merged into the Air Technical Service Command, which now had both sets of responsibilities and new responsibilities for coordination and control (191).

The new organization seemed to be more effective than the mixed responsibilities of the previous two commands. However, R&D was still not very active in the Army Air Forces. In March 1946, the Air Technical Service Command became the Air Materiel Command responsible for supporting the Army Air Forces in logistics, procurement, and R&D. Additionally, it was charged with the task of rejuvenating the mordant Air Force R&D effort. Progress seemed to be recognizable, but AMC was primarily a logistics agency, not a research agency. Its focus was on improvements to equipment and toward service and production engineering. More often than not, basic research took a backseat to applied research. This created fear in some circles that the technological base would suffer to the detriment of the defense mission. Therefore, a special committee of the Air Force Scientific Advisory Board examined the situation and recommended R&D be placed in an organization of its own. The action on this recommendation created the Air Research and Development Command on 2 April 1951 and separated its functions from the Air Materiel Command.

Recognizing the need for closer coordination of effort supporting new weapons system development, the two commands agreed to establish the Weapons System Project Office (WSPO) to be located in each weapon system management office. The WSPO was charged with managing the transfer of responsibility to manage the transfer of responsibility between R&D and production and then to field support. It was used successfully in the B-47 and B-52 acquisition programs.

In April 1961, the Air Research and Development Command became the Air Force Systems Command (AFSC), and the Air Materiel Command became the Air Force Logistics Command (AFLC). Their responsibilities have not changed much since that time. They continue to work together and in 1974 created a deputy program manager for Logistics (DPML) in each system program office. The DPML is the responsible agent for logistics support considerations and actions in new weapons systems development and procurement. Further actions included the 1976 creation of the Air Force Acquisition Logistics Division as a bridge between the two commands and the later creation of the Acquisition Logistics Directorate in the headquarters of the Air Force Systems Command (191:23-40, 235).

The Postwar Economy

The postwar US national economy was growing and employment was high. Personal income rose and the pent-up demands of the Depression and war years were being satisfied.

Chapter Four

The Berlin Airlift: Project Vittles

From the end of the war, the Allies had experienced trouble with Russia about the occupation of Berlin. US troops had been the first to approach Berlin but had held off entering to permit the Soviet Army the privilege of being first. The Soviets seemed to take that as admission of low Allied interest and, while they got what is now called East Berlin, wanted the Allied forces of the United States, United Kingdom (UK), and France out of what is now West Berlin. Frequent and often serious conflicts arose because the Russians occupied all territory surrounding Berlin and accepted, reluctantly, the right of the Allies to enter using air corridors, rail lines, or the autobahn. Often they provided trouble and delay for cargo and passenger movements on the ground arteries.

On 24 June 1948, the Russians halted all rail traffic into Berlin. The day before, they had imposed severe inspection on road traffic, which, for practical purposes, stopped it. Berlin became a city under siege with the only open artery the three approved air corridors from West Germany. The obvious goal of the Russians was to harass the Allies into evacuating Berlin. It seemed the Allies had only two choices. One was to fade away and leave Berlin to the Soviet Union. The other was to call the bluff and stick it out in Berlin. They chose to do the latter and decided to supply Berlin by air. This would involve all essential supplies for the Allied forces and the 2.5 million civilian population being airlifted into the besieged city. The airlift would have to provide, in addition to military materiel, all the sustenance, medical, and fuel needs for basic existence in the city.

The first flights of the Berlin Airlift, called *Project Vittles* by Americans, were C-47s from Wiesbaden Air Base, Germany. These were relatively small aircraft, the World War II *Gooney Bird*, which had hurriedly been changed from passenger configuration to cargo for the lift. Even so, they were really not able to handle much weight or bulk. The challenge was great. West Berlin normally consumed about 20,000 tons of food and other supplies a day. The hastily computed minimum subsistence level was 4,000 tons per day. The entire C-47 airlift available to us would provide a maximum of 700 tons per day. It was clearly a no-win situation, but the airlift would at least prove our determination to keep and support Berlin.

Soon the United Kingdom joined us and flew sorties in coordination with those flown by US Air Force and US Navy crews. The United States called in the available, larger C-54 aircraft from US and Pacific bases to meet the airlift need. The Army Signal Corps provided essential around-the-clock communications services, and the Army Transportation Corps found and moved all the supplies via the ground. In a few days, by Presidential direction, the Strategic Air Command placed more than 30 additional B-29s, with atomic capability, in the United Kingdom to show the US resolve to stay in Berlin and protect its position (114:13).

General LeMay, Commander, US Air Forces in Europe, formed an airlift task force on 30 July with Major General William Tunner, called in from the Military Air Transport Service, as its head. Tunner had assumed command of the *Hump* airlift in the China-Burma-India theater in World War II and turned it into a successful operation. He now proceeded to do the same with the Berlin Airlift. In October, the United States joined forces under Tunner's command of the Combined Airlift Task Force. The mission assigned the task force was to provide at least 4,500 tons of airlift supplies per day to meet the basic essential needs of Berlin citizens and the military. Before the lift ended, they were providing an average of more than 800 tons per day (230:55). By the end of the lift, for every 260 tons flown in to Berlin, 100 tons of manufactured goods were flown out because the Berlin economy continued to improve through this period. (42:162).

The Berlin Airlift ended on 12 May 1949 after more than a quarter million sorties delivered more than 2.3 million tons by air (83:55). The United States employed 336 aircraft (C-47, C-54, C-82, C-97, R5D), and the UK employed 100 (Dakota, York, and Hastings).

Aircraft departed Frankfurt on block times four times a day (midnight, 0600, 1200, 1800). Each block had 70 C-54s taking off at 3-minute intervals and returning for new loads 4 hours and 20 minutes later in all kinds of weather and with frequent Russian harassment. The airlift flights were *attacked* by Russian jets. The Russians installed barrage balloons and often changed their positions and altitudes. Ground forces attempted to blind flight crews with carefully aimed high-intensity searchlights. None of this met the Russian objectives, and the flights continued in all kinds of weather and with all the harassment. In all, for various reasons, 65 people died in airlift activity.

The airlift had been a massive ground-handling job for traffic controllers and transportation people. It had constantly created really hectic problems for flight controllers. But close scheduling and precision operations on the ground and in the air were successful.

Maintenance was done in Frankfurt, Wiesbaden, and the UK by military and civilian personnel (18). They did a superb job. Much of the military forces of the United States and the UK in Europe had been somehow involved. An estimated 75,000 military and civilians on the Continent took part in the airlift. The cost is estimated from $200 to $300 million, but it provided superior airlift training in all kinds of conditions and created outstanding international relations (42:162).

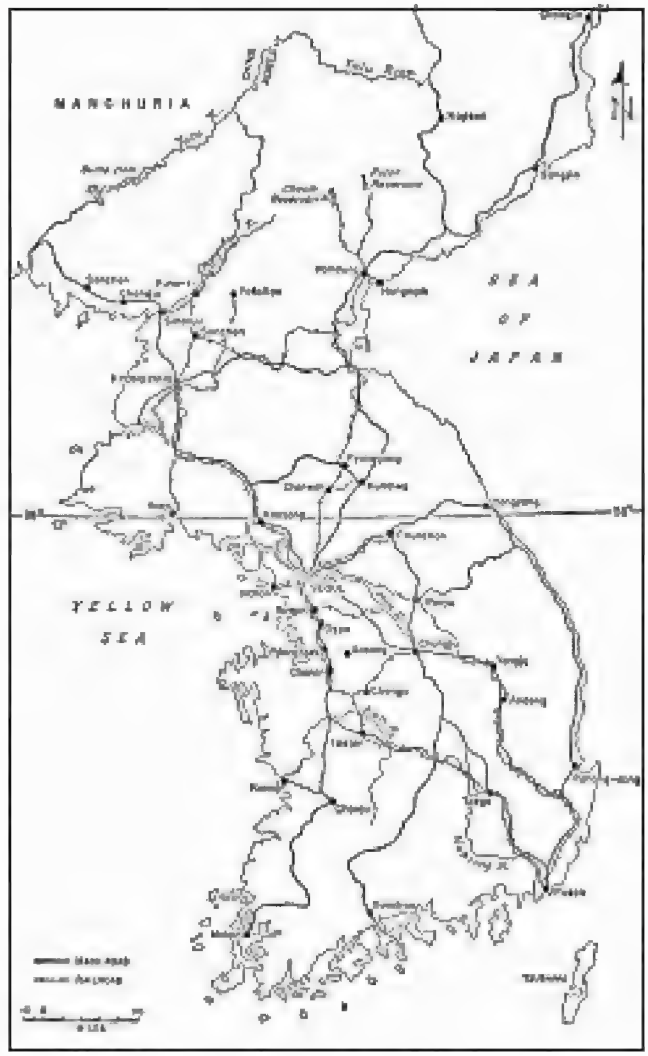
The Berlin Airlift was expensive and sapped a great portion of the US military air capability. But it proved aviation was a valid and potent military arm for national policy support. It also proved we needed development of specially designed military airlift aircraft of much greater capacity than we currently possessed. The continued use of modified civilian airline aircraft would no longer be practical. The development of bigger, more capable military airlift began under more favorable conditions as a result of the lift.

Chapter Five

The Korean War

As earlier indicated, the end of World War II brought massive and rapid demobilization. The government followed a deliberate policy to provide everything possible to the civilian economy in an effort to stimulate the economy and hasten the return to peacetime production. Some of that action, in retrospect, was not wise. When the Korean conflict began in 1950 with the resultant expansion of the US military, the lack of machine tool capacity caused by the demobilization made industry unable to handle the spurt of military equipment orders. The earlier disposal and demobilization actions had been unwise. So, too, had been the failure to adequately finance the care and maintenance of government-owned industrial facilities and equipment. Many of these were allowed to sit idle with little or no care, and they quickly deteriorated and were not readily available when needed for the Korean War effort (39:52). Additionally, the merchant fleet had been allowed to decline in the postwar period. When it was needed for Korean support, it was not fully capable.

Some actions, though, were beneficial. Congress passed the Strategic and Critical Materiel Stockpiling Act in 1946, allowing and directing the beginning of strategic stockpiling for critical materiel. The National Security Act of 1947 created the National Security Resources Board charged with responsibility to coordinate military, industrial, and civilian mobilization for the federal government. The Armed Forces Procurement Act of 1947 gave the military a means of protecting and building up an industrial mobilization base. It permitted the exception of certain contracts from competitive bidding when it was determined a specific contractor should be retained in business in the interests of national defense. The National Industrial Reserve Act of 1948 authorized the military services to retain surplus machine tools, manufacturing equipment, and industrial plants to supply the needs of the military for emergency production. All of these Acts and other decisions led to government planning for mobilization and joint planning with industry, which was helpful when the Korean War took place (39:53-5).



Korea

The Korean Nation

The Korean peninsula offers ocean outlets and a doorway to Japan and the rest of the Far East. It was controlled by Japanese invading forces before our entry into World War II. Assuming control of the country was clearly an aim of the Communists for the reasons mentioned above. During the war, the Korean people had made clear their desire for independence. This was recognized by US, Britain, and Chinese leadership in the Cairo Declaration of 1943 pledging Korean independence *in due time*. The Potsdam Declaration in the summer of 1945 reaffirmed the aim.

One of the stipulations when the Japanese surrendered was for the Japanese forces south of the 38th Parallel in Korea to surrender to the American commander. They did this as son as the American troops arrived on 8 September 1945. There was no formal wartime agreement between the United States and the Soviet Union to divide Korea. The division at the 38th Parallel was solely a temporary objective to facilitate the Japanese troop surrender. It was, in retrospect, an unfortunate choice, which led to the problems of a divided country with two opposing political concepts.

A joint US-Soviet commission exercised trusteeship over the two segments of the country with continuing disagreements. As it happened, regardless of intent, two separate countries were established. Russia refused to permit North Korean people to participate in the free elections in May 1948, but about 95 percent of the south voted for members of a national assembly. In July, the first constitution in 4,000 years of Korean history was developed, and Syngman Rhee was elected first president of the Republic of Korea. That government took over on 15 August 1948, and US military government ended.

The UN recognized the republic as the legitimate government of Korea, but Russia vetoed the action. From that point on, the government of South Korea was subjected to continuous provocation by the North. The North began aggressive military maneuvers, often crossing the border and retreating when challenged. But the scene was set, and confrontation was ensured for the future.

The War Begins

On 25 June 1950, the armies of North Korea crossed the 38th Parallel in all-out attack against South Korea. It quickly became obvious this was not to be another of the many quick in-and-out incursions of the past. The next day, President Truman, supported by a UN Security Council resolution, ordered air and naval support of the South Korean forces (40:47). The South Korean capital, Seoul, fell to the invaders on 28 June, and on 30 June, President Truman committed the US Army to ground combat supporting South Korean efforts to resist the Communist North. This prompt action by our government was helpful to the South Koreans, and it also reassured those countries around the world relying on US support and protection. Thus, places like Berlin, Greece, and others could feel more certain of help, if needed, because the United States was proving its intentions in Korea.

In a number of ways, the US entry into the Korean War was very similar to its entry into World War II. It was not truly ready for war; yet an ally, a friend, was involved in a life-or-death struggle against an aggressor. We wanted to help our friend survive and stepped in to assist. Initially, in both instances, it was thought logistics support, alone, would be all that was required. But circumstances happened to make our combat commitment of military forces necessary, ready or not.

The military again was not ready for war (207, 40:47). The Services were probably better off than they were for the start of World War II, but we had not prepared for war in Korea or in any similar remote, small area. In the 5 years since World War II, we had thought only of another total war. We had put most of our money and attention on strategic nuclear power and had permitted our stocks of conventional ground and air war materiel to deplete to dangerous levels (207). The Marine Corps was in worse logistics condition than ever (40:49).

The invasion of South Korea presented us with two immediate needs. First, we had to meet the requirements to stop the North Korean armies. Second, we had to meet the requirements for a general military buildup to face the heightened threat of worldwide aggression indicated possible by the Communist invasion from the north. Our top political and military authorities decided US policy would be to meet these major military needs while simultaneously helping the Gross National Product and the civilian standard of living to continue to grow. The thought was this would cause the American people to more readily support the large-scale military spending if their lives were not too greatly disrupted.

The decision of the US government was to enter into a military offensive in Korea but not declare war. The Congress and the Department of Defense generally worked together on these problems and created an industrial base to support the war while meeting the stated civilian goals as well. It is important to note that behind these decisions was the thought we faced a long period of tension in the world and not just the immediate crisis in Korea.

On 30 October 1950, Red China joined North Korea and sent its troops into battle against the UN forces in South Korea. They swept the South's troops away in their first attacks. The South Korean Army retreated leaving great quantities of military gear on the battlefield for the invaders to salvage. In response, to reequip the South Koreans, the United States resorted to a form of *block load*, which had been found troublesome in World War II. We immediately shipped from the

United States all the supplies and equipment required by tables of allowances for a complete infantry division. As before, this method of supply moved much materiel in a hurry to a specified site. But it was not necessarily the same equipment needed by the combat commanders in the field. However, Washington had not asked them what they needed but had acted unilaterally and, as it turned out, mistakenly.

Inchon invasion. LCVPs from *USS Union* (AKA-106) circle in the transport area prior to going to the line of departure off Inchon, 15 September 1950. An LST, QO-12 is in the background. (Courtesy of National Archives)

Beginning Logistics Problems

At first, there were inadequate considerations given to logistics problems, and not much of the lessons of World War II applied to the situation. As the conflict aged though, logistics problems did get considered, and most were solved adequately for combat success. The major problems were:

- The long 5,000 or more sea miles from the United States to Korea.
- The lack of adequate ground transportation in Korea and at the ports.
- Very little support could be expected from South Korea since the Communists had grabbed most of the industrial base of the South.
- North Korea had vast hordes of arms and ammunition, which had been left in Manchuria by the Japanese. They also had the American military materiel left in China plus the Soviet materiel available through Red China's forces.
- Necessary rework of US World War II equipment abandoned and now recovered on South Pacific islands.
- The industrial bases of Japan, the Philippines, and other Pacific basin countries could only be used if adequate transportation were made available to move products to Korea.

For example, the landing at Inchon in September 1950, which led to the recovery of Kimpo Airfield and Seoul, could not have been accomplished without the US Navy LSTs of World War II, which had been sold or given to Japanese shippers for interisland shipping (40:50).

While not specifically a logistics problem in itself, we must consider the seemingly ever-present mud in the Korean War. Many of the roadways were not roads in the strictest sense but rather dirt trails widened for vehicles. They were often extremely muddy for long times, and that mud often prevented vehicle traffic. This forced combat units to rely on human transportation, American GIs, or Korean carrier troops to move essential supplies. Even this was difficult because the mud and continual sliding and slipping was very hard on leg muscles, requiring frequent relief or change of personnel. Then, too, the mud was deep, sticky, and much like glue. Troops often complained they had to pull their feet from their boots in order to escape from the mud. Bootless feet in the slimy mud led to further physical problems and added work for the medical units.

Rain seemed to be a constant companion in the spring and summer, thus retaining the mud conditions. In the winter, it was extremely cold with frequent heavy snow, strong winds, and cold rains. Again, the mud was ever present. As troops would break through the snow crust or freeze hardened soil, mud would develop. If there was anything worse than the spring and summer mud, it was the freezing winter mud. All of this tended to make supply to the combat units a very difficult operation. Munitions loads were very heavy and munitions expenditures very great. The need for manpower to lug munitions depleted combat force availability and added to the medical support problems.

Summer and spring were also famous for flies, fleas, and lice. Troops in deployed forces were constantly beset by these insects. They were not only a general nuisance but also very dangerous because they brought various forms of disease further adding to troop management problems and combat capability reductions.

Logistics distribution was hampered by terrorists from North Korea. They often could not be distinguished from South Koreans, and they mingled with the large masses of South Koreans. They could, almost with impunity, block bridges, destroy elements of the infrastructure, drop grenades from bridges on United Nations troops below, toss grenades into passing military vehicles, and so on. All of this caused confusion and delay in the distribution processes. In the early fighting, the UN forces and the South Koreans had few weapons and limited munitions support. They had not planned on war. The North Korean situation was quite different. They had planned for war and seemed to have almost unlimited Soviet artillery, tanks, and munitions readily available.

Beginning Logistics Advantages

Though it might not seem an advantage, it is important to note that the Eighth Army fought with practically the same weapons and equipment used by the US Army in World War II. A good portion of the troops and their officers were veterans of World War II. They remembered the equipment and found it easy to slip back into its use in combat. Further, the military processes and procedures of World War II were still in place, and these were remembered and easily used. Thus new units being introduced into combat in Korea had a good chance to enter with some degree of familiarity with their surroundings other than the country itself.

Much of the equipment and supplies abandoned on the Pacific islands during the massive and rapid demobilization following World War II was still available. Salvage and pickup crews dispatched to these sites were able to quickly make great quantities of this materiel available to the forces in Korea. It was good they could because there had not been much procurement of military materiel since World War II. There were not many combat supply stores in Korea or the Pacific because war so soon had not been considered.

Japan was nearby and had a growing industrial base. Equipment salvaged in the Pacific could be quickly reworked in Japan, if necessary, and delivered to Korea for use. Japan offered much more of value. The United States had installed Army, Air Force, Marine, and Navy depot facilities in that country after World War II. Thus, the seed for expanded support of the combat units was available. Japanese workers were skilled, competent, and available. Civilian industrial facilities were being rebuilt with modern machinery and procedures. The transportation systems had been revitalized, and supply distribution was efficient and effective. Japanese businesses sold back to the United States the LSTs they had acquired after the war, and these vessels became the early naval support for the fighting forces in Korea. And, too, Japan offered a haven for combat-weary troops and wounded persons needing hospitalization.

Procurement

The US government was deeply concerned about the possibility of unwisely building up military capability to support South Korea at the expense of maintaining the strategic European forces. Much policy discussion resulted in a decision to emphasize materiel buildup prior to manpower buildup. The Secretary of the Army cautioned that too rapid a buildup in manpower would demand industrial capability for training materiel and delay building up stocks for combat potential. The result was that procurement became the primary item of importance in the early efforts (119:621-5).

The military involvement in the defense of South Korea set in motion a large-scale increase in procurement actions. Materiel, equipment, and supplies had to be quickly obtained to replace those that had been immediately shipped to Korea and Japan at the start of hostilities. Urgent action was required for winter combat clothing because we were not prepared for large numbers of combat troops to be engaged in the almost Arctic weather found in the Korean winter. We needed equipment and supplies for amphibious and airborne operations. Munitions of many kinds had to be obtained in huge quantities. Aviation parts for Air Force, Navy, and Army aircraft were urgently required.

Additionally, we needed rapid acquisition of other requirements to support our Armed Forces in other areas under the potential of a worldwide threat from Communist powers. Therefore, procurement agencies were immediately and actively involved in greatly expanded contracting efforts to speed up the armaments programs and energize and broaden the industrial base to permit further expansion if necessary.

To accomplish their tasks, the procurement agencies worked competently and quickly with contractors in the United States, Japan, South Korea, the Philippines, and many other locations. They found new sources of supply. They convinced manufacturers to change their products to meet military needs. They argued for priorities and most often won. They sought fast deliveries and worked constantly with contractor management to ensure scheduled production completion. Our buildup success is a success story for procurement probably more than any other single logistics element.

Construction

Construction problems in Korea were magnified by the mean and changeable weather conditions and, in the early fighting,

Invasion of Inchon, Korea, as four LSTs unload men and equipment on beach. Left to right are LST 611, LST 845, and LST 715, 15 September 1950.

by the continual seesaw of troop locations. As earlier mentioned, mud and extreme cold were problems for all the troops. Construction efforts were handicapped as well. In addition, the shortage of construction materials added to the problems of the military engineers for a good part of the war. The introduction of jet aircraft to combat areas created new problems for construction. These were problems not experienced in prior combat scenarios and, therefore, were not anticipated. Runways adequate for propeller-driven aircraft were not entirely satisfactory for jet operations. Jet aircraft tend to have smaller tread tires and tires inflated to higher air pressures than normally found on conventional aircraft. This established requirements for runway surface conditions considerably finer than earlier construction. Further, the smaller tires make for greater weight per square inch of surface thus demanding stronger bases and surfaces.

Pierced-steel planking (PSP) used in World War II for runway and taxiway surfaces was again used in Korea. In World War II, the PSP had created problems as its subsurface deteriorated, allowing the PSP to sink or form indentations in the surface. Sometimes the PSP would bend under the failure of the subsurface and create a knife-like edge that destroyed tires and often caused aircraft landing gear failures and accidents. The same problems were found in Korea, but the problems were magnified by the sensitivity of the jet aircraft with their smaller tire surfaces, heavy loading, and higher landing speeds. Further, it was found that landing strips for jet aircraft had to be longer, and this made for additional construction problems.

Where possible, construction engineers made runway and taxiway surface of blacktop. It was the preferred construction medium because it offered smoother surfaces and generally fewer maintenance problems. Plus, it eliminated the massive task of handling great numbers of heavy pieces of PSP. However, blacktop was not totally satisfactory. Fuel leaks were frequent problems, and the jet fuel, in particular, was very corrosive on the blacktop. Maintenance of the surface was a continuing problem in these conditions. Another problem with the jet aircraft was the exceptionally high temperature of the exhaust blast from the rear of the engine, which tended to soften the blacktop and make it susceptible to high-speed air erosion.

The newness of jet aircraft caused construction planning problems. For example, at one site known as K-2, the planning for the runway was changed several times before construction was complete. Originally, it was planned to have a 3-1/2-inch blacktop surface covered with PSP. There were PSP segments all along the sides of the runway under construction. Then specifications were changed to make the blacktop 6 inches thick and use PSP only for the last 500 feet of the runway. This meant that 1.2 million square feet of PSP onsite was not needed and had to again be moved (342:40-1). This led to large-scale waste of scarce transportation and manpower. It was not just K-2 that experienced this form of logistics nightmare—K-2 is used only for illustration. The changes meant delay in complete and, worse, delay in the use of the strip for combat and combat support purposes. We really cannot afford much of this in wartime, and it is a major lesson to be learned from Korea.

Construction of storage sites for supplies, foodstuffs, and munitions was of vital importance. This construction was essential because of the weather problems noted earlier and of such priority it often forced the engineers to forego other efforts in order to apply all available resources to this requirement. So, too, was the importance and priority of roadways and bridges to permit continued supply of combat forces as they maneuvered against the North Koreans and Red Chinese forces. This was particularly vital for foodstuffs and munitions.

Where possible, great efforts were made to provide some form of protective housing for troops. Of course, this could not be done for the troops on the line in combat, but it was done as close to the front as possible. Every effort was made to provide near-at-hand relief areas for combat troops, including shelter from the elements, laundry and shower facilities, mess areas, and medical care accommodations. All in all, military engineer units of all Services were outstanding in their accomplishments under such adverse conditions.

Supply

A number of critical supply problems occurred with the buildup for Korea. Stockpiles of ammunition became very touchy because ammunition was used at a much higher rate than ever planned. Helicopters were in short supply as were spare parts for all aircraft operations. Jet aircraft were available in limited quantities in the Japan-Korea area. The Far East Command had only a few F-80 jet aircraft. All other aircraft in the command were propeller-driven equipment left from World War II. Combat clothing was sorely needed. Cold weather gear for combat and support troops and aviator oxygen equipment were critically short. Tactical radios and portable radios were missing from many combat elements. A number of these items remained critical for most of the war.

Official DoD thinking in the first half of 1951 was that the war would be ended by the end of June that year. This thinking restricted the purchase of supplies because no procurement for combat occurring beyond that date was permitted. The order and shipping time for Korea was 120 days. That meant all supplies for combat actions after 30 June 1951 had to initially come from the depletion of depot stocks (at the expense of the rest of the US forces) or by diverting production intended for other worldwide commitments (119:623-4). Thinking changed, of course, after 30 June when it was obvious the war was not ending and we faced much more combat if we were to remain in South Korea.

Similar to World War II, there soon developed an internal conflict about supply priorities. The conflict basically revolved around the challenge of active combat in Korea and the strategic forces in Europe. Many high officials in the Department of the Army believed Western Europe was the most important US strategic area. It should, they argued, get top priority for supplies and equipment. Obviously, those in the Far East Command and particularly those in Korea saw it

differently. The combat reverses in Korea and the detailed reports of losses caused by the lack of military equipment pushed the Far East Command to top priority finally.

Further, there was an argument strongly made for the continuing supply of our Allies who were scheduled to receive military equipment under the Mutual Defense Assistance Pact and through NATO commitments from the United States. The emphasis finally went, as stated, to the Far East Command, but great effort was made to provide essential supply upgrade to the other military customers.

Even after the priority problem was resolved, heavy tonnage from US-based stocks of all war materiel was moved to Korea often at the expense of other areas in the world. Despite this, shortages continued, although aside from cold weather gear and ammunition, there is no indication the shortages seriously affected our fighting capability. The more serious problem developing was the depletion of US depot stocks without adequate production to retain essential reserves and continue to supply our forces worldwide. The redeeming factor was that the war in Korea was localized, and as in World War II, we were given the time to correct our deficiencies.

The primary source for supplies was the United States. However, there was significant support from the recovery of abandoned and excess World War II materiel, which were then modernized and rebuilt in Japan and the Philippines for use in Korea. This included ammunition, artillery pieces, combat vehicles, general purpose vehicles, and support equipment. Also, the procurement of some supplies was made through the host of small merchants available in Japan, the Philippines, and the free areas of Korea. However, they all, at this time, lacked large-scale production capability and capacity.

The Army used 10 general depots in the United States plus 39 branch depots (for items of signal ordnance, quartermaster, and chemical responsibility). However, the Army did not have intermediate depots in Korea, although it did use a few general depots such as the one in Pusan. These were at the end of a long pipeline with all the difficulties of transportation always somewhat of a problem for distribution. In the early months of the war, the supply system operated almost totally on the *push* concept in which materiel was shipped based on planned needs rather than on requisition. This was similar to World War II and produced similar results—uneconomic use of shipping and transportation, jammed ports, loss of control of critical supplies, and waste (119:634-41).

In World War II and earlier wars, the leadership had found the soldier unwilling to carry much he did not feel he would need. As a result, when the military service directed certain items to be issued to and carried by the combat soldier, some of that was soon cast off and abandoned in the field. This condition existed in Korea despite the fact there were significant shortages of supplies at various times. The GI just would not carry anything he felt unnecessary.

The general rule was to issue all materiel some authority had deemed necessary and published in a table of allowance. In peacetime operations, this caused no real problem other than dissatisfaction on the part of the soldier. In combat though, it creates a major problem because the soldier cannot carry it all. In peacetime, part of the table of allowance was stored in the soldier's duffel bag and seldom moved. The balance was in his combat pack and was usually loaded according to the table of allowance and not the field conditions. As soldiers approach their first combat, they are inclined to think the authorities know more than they. Therefore, they try to carry the entire TA load on their backs. They soon find they cannot do that and begin to abandon items in order to carry greater ammunition and survival loads. It does seem we still had not learned from the lessons of the past and continued to overload the soldier.

Class I	Articles consumed at approximately uniform rate. Examples: rations.
Class II	Articles authorized by Tables of Basic Allowances. Examples: radio sets, tools, weapons.
Class III	Engine fuels and lubricants. Example: diesel fuel, other POL.
Class IV	Articles not authorized by Tables of Basic Allowances but needed for operations contemplated or in progress. Examples: barbed wire, construction and fortification materials.
Class V	Ammunition, pyrotechnics, mines, chemicals. Examples: 3.5-inch bazooka round, .45-caliber ball ammunition.

Figure 4. Classes of Supply, Korean War

Overload was usually well intentioned and aimed at soldier survival. The intent was to keep the US soldier the best supplied in the world. But the decisions on unit and individual loads seemed never to be subjected to review or alteration from experience. Once when inspecting a unit, for example, a general officer found a man who had only two pairs of socks. He ordered every man in the division to carry six pairs. These were issued over the objections of commanders who knew the men would soon throw away the extra, unnecessary socks (342:186).

Many of the units in the field and supply forces in the field expressed great dissatisfaction with the supply system procedures. One Quartermaster Corps officer said, "From the tragic days of Taejon, we have sensed a passive indifference to our requirements for individual and unit equipment." He added, "It was understandable that supply confusion should exist at first. But I do not understand why the supply authorities should resist our legitimate requests with criticisms that we were using too much. How were we using too much? What known yardstick of modern US logistics could be applied to this long series of defeats and withdrawals (342:187)?

Supply conditions were often bad for the combat units and threatened their ability to fight and survive. Some units assigned people they really needed for combat as *expediters* near the general depots and ports in the United States and Korea. Their job was to ensure the most sorely needed items were handled and moved with priority. In this manner, the combat units were, on their own, working to overcome a logistics problem created by the push of supplies and not solved by the logistics system. These people did a tremendous job for their units and were able to shake the system sufficiently to redirect efforts to solve some of their unit supply

problems. Of course, in the doing, they may have created other problems and might have commandeered some supplies not really theirs.

The Air Force, too, was unprepared. The Far East Air Forces was not modern. It was equipped principally with World War II aircraft and equipment such as the F-51, B-26, and B-29. The Air Force supply system and supply levels were inadequate for war. The system lacked trained and qualified people. Facilities at bases in the Far East were inadequate or lacking. There were no true logistics or service units available to support combat operations. Supplies were so poorly recorded they were often *lost* on paper although physically present somewhere in the system. Warehousing was woefully short, and supplies were often damaged or destroyed by weather and corrosion. Additionally, in some overseas locations, including Korea, inadequate security brought about theft of grand scale and subsequent inability of the system to do its expected job.

On 6 November 1950, the first MiG-15 jet fighter was sighted over South Korea (235:104). A new element was added to air war, and the United States reacted by ordering the rush movement of an F-86 jet wing from the United States to Korea. Further, the Air Force began the callup of Air Force Reserve and Air National Guard units, which would, ultimately, serve with distinction in Korea and other locations. However, the Air Force had no experience factors for the use of jet aircraft in combat. The supply system had no idea what parts and support needs would exist. The Air Force did not know whether the aircraft could withstand the rigors of combat use. Additionally, there was the problem of an already weak supply system accommodating parts and supplies for both types of aircraft (207).

Other aviation shortages were finally overcome, but they were significant problems for considerable time. They included auxiliary power units for ground support and maintenance of the aircraft, oxygen masks for aircrews, jet helmets, and brackets for mounting external fuel tanks and/or underwing ordnance. In some instances in 1950-1951, jet pilots were using football helmets for protection because there were no jet helmets available (248:43-5).

Clothing

The weather in Korea ranged from that comparable to Washington DC to that comparable to northern Maine. Temperature extremes and plentiful rain or snow made for many problems housing and protecting troops. In particular, the problem was greatest for troops on the Army and Marine combat line and for flight and ground personnel of advance Air Force installations.

Clothing was of supreme importance. In the exceptional cold of the north, clothing made the difference between a capable combat troop and a troop barely able to survive, let alone fight. Yet, for part of the early days of the war, winter clothing was not really available. Combat personnel suffered severe frostbite and other debilitating injuries from the weather. Very often, the problem was not with the available clothing in the Pacific theater but rather conflict in movement and distribution priority with clothing and munitions, POL, and food. The clothing received the lower priority, and the troops suffered. Of course, had the priority gone to clothing, the troops might have suffered even more from lack of munitions, fuel, or food. It was a major supply dilemma.

Many of the people on the line had received little or no training in cold weather survival and cold weather care of their clothing. The shoepac was devised to serve in snow and ice in place of the combat boot. It was more suited to the conditions, but because some troops did not know the weather survival needs, the shoepac failed. It seems the officers believed the combat boot was better, in the absence of better knowledge, and encouraged their men to wear them rather than the shoepac because the boots were lighter, and they thought them better for marching. But a leather boot gets wet rapidly, and then it freezes. When this occurs, there is no way the person can gain a dry change of footgear no matter how often socks are changed. Thus, the troops acquired trenchfoot, frostbite, or worse, resultant evacuation and loss of capability in the unit (342:174).

When it was necessary to ford running streams, even in below freezing weather, the troops did not know how to save their feet. If they had not received proper training or if their officers did not insist on the following proven safeguards, they soon lost the ability to continue to march because their feet froze. They forded the creeks wearing their boots. Experience had shown that the correct, although difficult, thing to do was to remove both shoes and socks before fording the stream. Once on the other side, they should have put their dry socks and shoepacs or boots on. That way their feet would have stayed dry and healthy (342).

In the heat of summer, the GIs discarded much of the heavier winter clothing. As they quickly became heated from the sun and their exertions, they dropped more clothing. Sometimes, entire units would be bare from the waist up, and many times, the troops would be severely sunburned. It seemed supply always lagged behind the weather and combat requirements. It also seemed the troops were rarely adequately trained about their combat clothing and personal health and hygiene. Officers and noncommissioned officers failed to maintain troop health discipline; therefore, the troops suffered needlessly.

As the war aged, the conditions cited were corrected or made acceptable. These samples of problems indicate another painful and costly logistics lesson.

Munitions

Ammunition was a major problem through the war and a serious one early in the buildup. Small arms ammunition, naval munitions, mortar shells, and artillery shells were the primary difficulties. The shortages were caused by a combination of factors ranging from production delays and difficulties through distribution problems.

The US explosives industry and ammunition plants were not sufficiently active to quickly meet this new need for massive supply. We had not maintained any sizable munitions production since we felt we had much left from World War II.

Production, therefore, was an initial factor in the shortages. But distribution was a factor as well.

Munitions shipments were caught in the long pipeline and port delays. Additionally, there were problems moving the ammunition once it was removed from shipping. Generally poor transportation facilities and the extremely rugged terrain in which much of the fighting was done contributed to horrendous movement problems. So, too, did weather. Heavy snows, freezing rains, frozen soil, mud, and other severe environmental considerations made distribution a major difficulty (119:630-1).

Ammunition expenditure was far higher than planned. UN forces were facing the massive manpower of the Red China and North Korean armies. Much more ammunition was expended trying to overcome our manpower disadvantage. For example, in 7 days in May 1951, 22 battalions fired more than 300,000 rounds of artillery ammunition at the enemy. By comparison, in December 1944 around Bastogne, 35 battalions fired about 94,000 rounds of artillery ammunition in 10 days (119:630-1).

A special problem was ammunition production back in the United States. This was caused by failure to keep production lines functioning after World War II. It was further damaged by public opinion. Many people strongly objected to munitions production and did what they could to prevent it. Demonstrations and marches against munitions plants were frequent. In many instances, this delayed efforts to get production flowing.

The production shortfall caused munitions supply shortages in Korea and worldwide for more than 2 years. Production was unable to catch up until after the cessation of hostilities. Most combat unit shortages were not the result of this production difficulty but rather a result of local distribution problems of the kinds already mentioned for other commodities. In fact, after action reports generally indicate combat forces received all the munitions required despite the distribution problems. However, it must be emphasized this was possible because of demands imposed at the expense of other units around the world.

The military services had established a 90-day level of munitions supplies to be held in Japan and Korea. We were unable to sustain that level, and frequently the stocks on hand fell below the established 60-day safety level. In an effort to overcome this continuing shortfall, munitions from units in other parts of the world were commandeered. Often those units were drawn down to dangerously low stock levels. The worldwide shortage caused considerable anguish and concern on the part of certain commanders and the advocates of priority attention to European troops. Four reasons were usually cited for the worldwide ammunitions problems:

1. Exceptionally high rate of fire in Korea.
2. The failure to maintain a munitions production line in operation in the United States between wars.
3. The 18-month lead time for establishing quantity production.
4. DoD-imposed budgetary limits for munitions procurement.

Munitions are peculiar commodities requiring supply processes somewhat different than the processes for other classes of supplies. Ammunition requirements cannot be measured in bulk terms alone. It does little good to know you need X tons of munitions because there are more than 500 different types of ammunitions and their components. While ordinary supply shortages can often be overcome through substitution of one item for another, such is normally not the case with munitions. It helps not one bit for a troop needing a .30-caliber ammunition to receive a .45 caliber. So the entire munitions supply and distribution process must be dedicated to delivery of the correct type and quantity of ammunition to the right place at the right time. This is made more complex by the fact that different types of combat create different types of need. Advance determinations of needs are exceptionally difficult, thus demanding the system be responsive and flexible to meet these ever-changing and often unpredictable needs.

To give illustrations of high-level demands, consider that in mid-1951 artillery was being used to create *walls of steel* against the enemy to halt their drives. In these efforts, the artillery fired at more than five times their normal rate with many gun crews firing at rates exceeding 250 rounds per gun per day. In 28 days, X Corps expended 25,000 tons of ammunition and, in 1 day, fired more than 1,800 tons. The ammunition supply personnel and units were taxed almost beyond capacity to meet these needs. In one instance, one munitions platoon in 1 day loaded 540 truckloads of ammunition for distribution—and each truck carried more than 4 tons. Again, a major logistics lesson to be learned (342:126-7).

During peacetime and in training, ammunition supply problems either do not exist or can be lived with. Such is not the case in combat. When fighting starts, organizations and procedures for providing combat-essential munitions are too often left to be developed by inexperienced and untrained men. The result, at worst, is combat failure and loss of manpower and other assets. At best, it causes waste, hoarding, confusion, and sometimes panic at critical points in battle. When logistics meets the demands of tactics, there is little inquiry into the miracle of munitions delivery. But the instant shortages hamper operations, there are inquiries into the minutest details of munitions logistics with particular attention given to movement along the pipeline. In addition, when combat shortages exist, they usually cause heavy follow-on supply runs through excessive demands on ammunition supply points, further depleting available stocks (342:125).

Again, it must be emphasized that the munitions people in all Services did their jobs well. It was truly rare, after the initial problems caused by the surprise attacks and strength of the enemy for a combat unit to experience impossible munitions shortages. All in all, the munitions job was successfully accomplished in Korea.

Surplus Property Planning

The Far East Air Forces and the Twentieth Air Force put much effort into planning to overcome the problems of excess or surplus property when the Korean War ended. They established organizational elements responsible for planing the end of hostilities and the rollup of supplies and equipment to avoid the hasty, wasteful actions that followed the end of World War II. Two materiel recovery squadrons were created and trained in the United States before being assigned to the Twentieth Air Force to do this planned property rollup. The squadrons were used in various supply functions to process excess property and prepare it for shipment. They worked effectively until the end of hostilities. The planning paid off and the surplus problem never really occurred (249:72-3).

Medical Support

Medical support in Korea was outstanding in all respects. From medical corpsmen in small units to general hospitals and hospital ships, the treatment was superior and effective. Survival rates for combat wounded were higher in Korea than in World War II, and many innovations were developed to improve care for the troops.

Battalion forward aid stations in Army and Marine units provided on-the-spot medical attention to the wounded, injured, or sick personnel. The forward aid stations were most often so close to the combat action they did not require special communications but could use the combat team radios or voice-powered telephones. The aid stations were primarily manned by corpsmen and perhaps a single medical administrative officer. It was rare for these activities to have a fully qualified doctor on duty. But then their function was to provide immediate aid directed to life preservation with evacuation of the seriously wounded to more capable medical units in the rear.

A common evacuation scheme took the wounded from the aid station, via stretcher carried by Korean bearers, to a medical pickup point. Here they were transferred to Jeep ambulances or the standard box ambulances for movement to a collecting station in the rear. Medics at the collecting station determined what was necessary for the individual, did what they could and had to do for life preservation, and directed further evacuation to a MASH, an area hospital, or whatever facilities were in use.

In other wars, the tendency was to move surgery as close to the combat scene as possible. In Korea, this was difficult because of the fluidity of the tactical situation, the limited highway network, the rough road surfaces, and the mountainous terrain. In addition, the weather (cold, snowy, wet, hot, dusty, etc) had to be considered. If air evacuation could be used, the hospitals could be more stationary and better able to do their best work. So the helicopter entered the picture and became a major medical gain of the Korean War.

The early helicopter evacuation units had four helicopters, four pilots, and four mechanics. Some grew to larger size as the need increased. The early helicopters were the Bell H-13 and the Hiller H-23. Each of them carried only the pilot for crew, but each had two baskets—or pods—for litter patients. If the weather was good, the altitude not too great, and the aircraft in good condition, another walking wounded could be carried next to the pilot. They performed miracles, but there were limitations.

The helicopter of the time was constrained. It could not fly at night, operate in bad weather, or land on steep sloping terrain. It needed takeoff space, could not fly in heavy wind conditions, and had range and altitude limitations. In the summer, they could do less than in the heavier air of winter. Further, the low altitude uses and the slow speed made them vulnerable to enemy ground fire. So the pilots and the ground forces had to learn the constraints and limitations in order to make the machine effective. They did learn, and together they accomplished the miraculous rescues we have all heard about.

Often the helicopter was used to bring in supplies or key manpower when coming forward to pick up wounded. So they sometimes became effective in both directions of their flights. But the helicopters could not evacuate all the wounded. Ultimately, the aid stations and the combat personnel had to learn to ask for helicopter evacuation only for those wounded who had head, chest, and abdominal wounds; multiple fractures; or great loss of blood. If the wounds were so great the rough ground carry and ambulance ride would further do serious harm, air evacuation was recommended. Also, it had to be remembered there was no in-flight medical care possible. The pilot could not do that and fly the craft. The wounded were in pods and could not be reached. Generally, the helicopter evacuation was only a short ride to a nearby collecting station or hospital.

Great effort was made to provide dental and optical care, as well as medical care, to the troops in the field. These were provided as near the front as reason would permit as well as in all the major medical centers.

Hospital ships served troops in Korea as they had served troops in World War II. The *USS Repose,* for example, served for slightly more than 2 years in active Korean support with only a few short respites for essential maintenance work. The hospital ships operated much as did those in World War II except they were equipped with the improved medical equipment to support gains realized since 1945. They and all other medical personnel were responsible for the lowest lost time and death rates in American military history. Their records would be broken in medical support of forces in Vietnam, but in Korea, they were magnificent.

Transportation

Although transportation was always a problem during the Korean War, the Military Sea Transportation Service, operated by the Navy, was efficient and effective. It smoothly operated the sealines from the United States to Korea and back but had only minimal capacity because of the failure of our country to retain an active maritime service following World War II. Some shipping was removed from storage standby and applied to wartime needs, but it was not enough to satisfy all needs.

Commercial maritime services were effective and well used. Those services provided the fastest sea transport across the Pacific and were used effectively through contract.

The Army introduced the CONEX (Container Express) shipment process early in the war. This new form of containerization proved very effective then and later in history. The CONEX units were steel shipping containers in which were placed smaller packages of uniform loads of compatible supplies. The containers were reusable and could be stacked three high. Their size allowed stowage in the hold of a ship or in squared masses on deck. One container could fit in the bed of the standard 1-1/2 ton truck, the historic 6x6 of World War II, available to almost all units. Several of the CONEX units could be carried on a semitrailer or on a flatbed rail car. Thus, the truck, semitrailer, and the rail car offered much freedom of choice getting to or away from a port. But most important, the CONEX provided secure and weather protected movement of supplies.

The basic problem, though, was more down to earth. It was the lack of adequate transportation facilities to move cargo out of port areas in Korea. The result was a long line of ships awaiting opportunity to offload often critical supplies. Some sat in harbors as long as 25 days, and the average in-port time during the Korean War was 22 days (119:630-42). Fortunately, the North Koreans never acquired active heavy-duty naval craft with strong offensive capability. Their air force was restrained by US Navy and Air Force fighter patrols, so the long harbor waits for supply shipping were not unduly dangerous.

Land transportation faced exceptionally rough requirements because so much of the combat was in mountainous, rugged terrain. Roads often did not exist, and trucks had to try to bulldog their way into the offload point. Frequently, this did not work, and trucks bogged down. The trucks couldn't make the delivery of the essential supplies, so the combat units had to send their manpower back to the truck to carry the supplies in on their backs. When it was available, the helicopter was a great help in this sort of supply movement. But the helicopters were also in short supply and had other vital functions to perform. They were not always available for supply.

The rail system in Korea was helpful. It provided support through a combination of UN military supervision over the system with Korean civilian operation of the lines. Trains were frequent and effective because the Air Force and the Navy generally kept the skies free of Communist aircraft that could have destroyed or delayed, them. The rail systems provided up to 30 trains a day with each train running 20 to 40 cars long. Obviously, though, the rails did not run to the combat units, which were in almost constant position shifting due to tactical activity. So again, the truck, the helicopter, and manpower had to be relied upon for the final move of supplies (119:643-4).

The helicopter became a major weapon of war in Korea. These little aircraft were armed not only with rockets and guns but also sometimes even rollout bombs. More important, they became the instrument for a significantly greater probability the combat wounded man could receive medical attention and survive. In fact, with the expansion of the field medical unit, the greatly increased Mobile Army Surgical Hospitals, and the helicopter transport of wounded, the survival rate for casualties was twice as good as in World War II and four times as good as World War I (251:281).

The Army, Marines, and Navy put the helicopter to great and effective use all during the Korean War. They used the little birds for observation, artillery spotting, combat liaison, medical evacuation, movement of troops in combat, movement of supplies in combat, withdrawal of troops, and so forth. The basic machines used were the Bell H-13 and Hiller H-23 for general utility needs and the Sikorsky H-19 and Piasecki H-21 for cargo requirements. The war proved the value of and need for these new military weapons. It further indicated a strong need for additional research and development of military helicopters.

Air transport, other than helicopter, was reasonably plentiful and highly capable. However, it required airfields and airfield support. Airstrips were, for the most part, pierced-steel planking like that used in World War II. And like World War II, that PSP created its own problems. At Tague Air Base in 1951, for example, the PSP runways were laid on an unstable base. They were pounded by as many as 10,000 takeoffs and landings per month. They were never fully satisfactory and finally went to pieces. They bent, they cracked, they broke. They required constant care and maintenance to keep three fighter/bomber groups active from that strip. The PSP was a continued danger to aircraft operations because of tire cuts, primarily, a condition not to be encouraged with explosive-laden aircraft. This was the identical problem experienced in World War II, yet we were still using basically the same, proven bad, material. The lessons of logistics are difficult to teach.

Food Service

Aside from those early bad days in Korea when the war was definitely going against US and UN forces, food service was very good. In those early days, when the combat situation was so fluid, food service was hit or miss, and many combat troops lived on the most meager of rations. Once the situation stabilized and the UN forces were able to hold their own against the enemy and advance, food service in general became quite good. In fact, it was good enough that many Army unit commanders could only complain about occasional shortages of black pepper, Worchestershire sauce, or catsup (342:186). Food service support was good because the war was in a constricted area. Many responsible food service people stated they could not have sustained the service and quality in an expanded area such as World War II. For instance, one officer sated, "I had more fresh meat in Korea in a month's time than I received in 3-1/2 years of Pacific service in World War II" (342:186).

Army food service made great efforts to feed combat troops good hot meals in forward areas at least twice a day when the field situation permitted. The usual service was breakfast and dinner with the noon meal left to combat or carried rations. The food service people succeeded a lot more often than they

failed. The method they established called for the meals to be cooked in battalion or rear areas then carried forward as far as possible in Jeeps. From that point, the meals were carried by Korean bearers toting large loads on A-frames or carrier straps.

The messkit created a problem. There was no way for water, other than drinking water, to be carried into the forward areas and no way to heat it if it did get there. So the dirty messkit could become a health problem. The solution was for clean messkits also to be carried forward and the dirty kits returned for cleaning in the battalion area. The messkits were carried in footlockers or comparable sized boxes. But then the GIs began to gripe; they wanted trays rather than messkits.

For rear area units and units in more permanent sites, the messkits or trays were cleaned by the user. Gasoline drums cut off at the top and filled with water were heated by oil. The messkit cleaning line was usually four to six drums. One or two drums at the beginning would be filled with hot soapy water. The other drums would be hot, clear water. The user would enter the cleanup line, dump uneaten food in garbage cans, and brush the messkit or tray to clear it of most residue. Then he would immerse the kit or tray in the hot soapy water, brush the surface, and proceed to the next drum. The action would be repeated if there were two soapy drums. The hot, clear water drums were for rinsing the soap from the kit or tray. The kit or tray was then air dried. Utensils were cleaned in a similar manner. Unless the mess provided a storage area, the kits or trays were retained by the individual. This procedure had been widely employed with success in all theaters of operation in World War II and in earlier field operation.

Bakery support was provided for geographic areas instead of identified with a division. This was no major problem except it meant the bakery was frequently quite far from the troop units being serviced. The troops thought the bakery goods were tasty and of good quality. Bakery equipment was in use almost around the clock, and this created maintenance difficulties because of burnout and wear-out. Transportation also was a problem of sorts. The bakeries usually had no means to wrap bread, for example, other than using brown paper bags closed with gummed tape. The bags did not stand up to rough handling and often tore. The trip over the frequently dusty or muddy roads and trails contaminated the bread. Some bakery products then had to be condemned. It took, on average, almost 5 days for the bread to reach the troops after being baked. Yet the troops liked it. Overall, the bakery service was good.

A food service problem existed in the support of foreign personnel in the UN forces. The Turkish soldiers would not eat pork. The Greeks would not eat sweet potatoes, corn, peas, and many other items. European soldiers wanted additional rations of bread. Troops from the Mediterranean area wanted vegetable oils and olives. Oriental troops were accustomed to heavy rations of rice, and other foodstuffs were considered merely adjuncts to rice. These cultural food differences caused a lot of waste because US commissaries were not equipped or supplied for such foodstuff diversity. Normal American rations were issued, and the foreign nationals used what they would and threw away the balance (342:269).

Combat rations and troop-carried rations were a must for most meals in the field when hot meal service was not provided. Most of the time, this was not satisfactory because the front-line troops had no means to heat these rations. They were widely considered unfit to eat cold, so many soldiers went hungry rather than eat them. When they could be heated, there were complaints about quality, particularly meat products. The C-ration, in cans, was not loved but was the choice of the troops for field use. Even though the C-rations were not always tasty, they could, at least, be eaten, and they were not any the worse if they could not be heated.

Maintenance

Aircraft maintenance quickly became a problem in Korea. The fluctuation of the battlelines caused constant movement of forces. The combat air units had to be mobile and responsive to immediate relocation needs. Thus, they could not have extensive maintenance facilities. Very often, they couldn't unpack essential equipment because they might very quickly have to once again move. So the Air Force was faced with a decision situation:

- It could attempt to continue following the basic wing-base concepts of the Air Force.
- It could exploit the idea of operating combat airstrips and units in Korea with support elements, including all but basic maintenance, in more stable conditions in Japan.

The decision to split the units created the rear echelon maintenance combined operation (REMCO) (251). It was a hard decision, but the Air Force had to face the realities of Korea. The roads, rail nets, and equipment in Korea were not adequate to handle rapid and frequent deployment movement of full Air Force units. Further, there was no assurance we could provide security forces to protect more-or-less fixed industrial facilities required for aircraft maintenance and inspection. Therefore, we also had to consider the threat of a potentially large loss of manpower and equipment to enemy action because most of the air units had to be reasonably close to the battleline. Thus, the REMCO was seen to serve most needs most effectively (251).

The support manpower and equipment of several units were combined to create a REMCO in Japan. The REMCO for F-84, F-89, and F-80 aircraft was sited at Itasuki. The REMCO for the B-26 aircraft was at Miho. The REMCO for the F-86 aircraft was at Tsuiki. At these sites, each could have suitable hangar, shop, and inspection dock facilities with adequate base support to do their extensive maintenance work. Meanwhile, the tactical elements of the wings, with only crew chief maintenance, would function on the small strips, with few facilities, in Korea.

Each wing had a forward control unit responsible for controlling the flow of aircraft to Japan and for communicating peculiar needs to the REMCO production control. All movement of aircraft was in compliance with the REMCO master planning and scheduling so the production and supply

elements could preplan and preposition required parts, supplies, and equipment.

The REMCO made all major inspections on aircraft, engine buildup, engine change, engine repair and overhaul, and all field level maintenance on aircraft and parts. The members of the Japanese Air Defense Force (United States and Japanese) provided all base support. Usually, the REMCO used a form of specialized aircraft maintenance to do its job. Immediately on arrival, an aircraft was provided a shakedown inspection to determine what, if any, work was required over and above that scheduled. The results of the inspection were provided to production control. That unit added the work and parts, to the schedule and informed the tactical wing in Korea (251).

The work at the REMCO was carefully scheduled so the availability of required specialists and equipment could be ensured on time for requirements. Further, all needed supplies were requisitioned in advance and prepositioned for ready availability when the work was being done. Specialists came to the aircraft at specified times to do specific jobs, and they were allowed only specific times to complete the tasks because others had to move into that same area of the aircraft.

The centralization of maintenance at the REMCO soon caused supply to also centralize at the same sites. The centralized supply provided support to the REMCO and the combat units in Korea for which they were responsible. The system worked well, but as effective as it was it was, it was not liked by the tactical commanders. They felt they had lost control of and identification with a significant element of their unit: the maintenance and supply functions (251:166-9).

The tactical commanders cited a number of disadvantages to the REMCO scheme, but they did not succeed in changing it because its effectiveness overcame its shortcomings. The principal complaints were:

- Too much aircraft and crew time was lost ferrying aircraft to and from REMCO.
- Weather changes caused the scheduled return of the aircraft to be missed, and missions either had to be scrubbed, or other already overworked aircraft and crews had to do double duty.
- The needs for increased communication capability and increased coordination were too great for a mobile combat unit.
- They found their maintenance and supply personnel assigned to the REMCO were unhappy and felt no esprit in a remote unit with no visible contribution to combat success.

The REMCO maintenance officers discovered that some tactical units were using the REMCO to rid themselves of undesirable and often incompetent personnel. Also, it was discovered some tactical units were misusing critical maintenance personnel making them only labor troops for mobility or supply toting rather than for essential maintenance tasks. It soon became necessary for the Far East Air Forces more or less to approve personnel assignments to a REMCO to avoid these problems. It was obvious the REMCO could not be effective and, in fact, could hurt the mission capability in Korea if it were manned with incapable personnel. It was equally obvious the tactical units couldn't do the required maintenance on their aircraft if the maintenance people were not properly employed, if their equipment was not available, or if they had no facilities from which to work in the often impossible weather.

The final reckoning of the REMCO indicates a successful effort. The maintenance accomplished and the supply support provided were, on the whole, exceptionally good. The mobility of the tactical wings was markedly improved, and the tactical commanders had fewer personnel problems to deal with. Further, REMCO permitted the use of specialized maintenance concepts, which were generally more economical. The maintenance could be done in permanent and efficient facilities with overall greater logistics support for the combat units.

Morale Logistics

The war in Korea offered numerous morale problems. The weather and climate conditions were notably detested by the troops. Probably more important to morale were the growing sentiments back in the United States that our involvement in the war was not necessary. As more and more of the news contained stories of public stands against the war, demonstrations at munitions plants, attempts to halt train and truck movements, and alleged sabotage of supplies, the troop morale suffered. Then, too, the draft caused morale problems. Those in college or high school could be deferred from service until they completed school. Those not in school were eligible for immediate drafting for military service. It seemed unfair to many, and the morale of those drafted and sent to Korea often fell.

So considerable logistics attention had to be applied to morale support. Mail delivery was of primary importance as it had been in prior wars. Even at the expense of displacing high-priority supply traffic, letter mail was generally airlifted to Korea for fast delivery. In the country, transportation priority went to mail deliveries so long as it did not interfere with absolutely essential combat support. The attention to mail prevented further deterioration of morale but, of course, could not overcome all the causes for low morale.

Movies, radio, and music helped. Movie service was maintained in every way possible. Whenever a unit was in position to safely have movies, it had them. The Armed Forces Radio System continually provided the music and news desired by the troops. It was a system very much like that of World War II and operated with equal—or greater—success.

But more was needed. The troops needed clean clothing and opportunities for warm showers as well. So the Army Quartermaster Corps established service centers that were highly successful. Similar activities were implemented by the other Services. The QM Service Center usually had laundry facilities, clothing rehabilitation and reissue operations, bathing facilities, and as best they could, housing to overcome the climatic conditions.

A service center would be established in a compact area near a flowing stream to provide continuous water supply. The laundry function was sited close to the clothing exchange and bath facility. Nearby was the messing unit and near that

the housing. A most important element of the center was the laundering facility. Men entered the clothing exchange and received clothing to use following their showers. The dirty clothing was then laundered for inspection by the reclamation and repair unit. From May to September 1951, QM Service Center No. 3 averaged 13,617 pounds of wash daily. In that period, 1,462,890 individual clothing items were washed (342).

A reclamation unit checked laundered clothing and repaired it before it was made available for reissue to another dirty GI. This unit repaired not only damaged clothing but also shoes, boots, weapons webbing, canvas equipment, and so forth. It was equipped with heavy duty sewing machines and other essential equipment.

The combat troops eagerly looked forward to their periodic visits to a service center. Keeping clean and getting warm were major problems, and they appreciated the service that helped them accomplish this.

Graves Registration and Repatriation

A sad but essential element of military logistics is the combined service of graves registration and repatriation of the dead. In every war, it is necessary to, at the very least, clear the battle area of the dead, if for no other reason than the health of the living. But of course, our American standards demand the dead be treated with dignity and care. Further, since these Americans were killed on foreign soil far from home, it was necessary to identify each body, control its internment, and register its burial location. Allied to this, of course, is essential embalming service. Then later, if the families desired, there was the need to disinter, prepare, and ship the remains for reburial in the United States or a designated overseas cemetery.

Closely connected with the above, of course, is the collection, processing, safeguarding, and shipping of personal effects. These processes of caring for the dead require specialized manpower, facilities, data collection, and record keeping. The personnel requirements range from pickup personnel to grave diggers to embalmers to anthropologist to forensic dentists to chemists and so forth. Specific special containers are required, and special transportation is needed. When a body is returned to the family, escort service is necessary. At home burial, it is often necessary to provide a military group for burial honors. All of this helps to preserve our American belief in the sanctity of the individual and the honors due those who die for their country. All of it is one more bit of the massive logistics system needed for creating and sustaining a military capability.

Air Force Command Problem

The Air Materiel Command was actively supporting the combat action in Korea but was not really satisfying the tactical commanders. The command was heavily involved in removing aircraft from storage at Davis-Monthan AFB and readying them for combat. It was also involved in supply through its depot system and its air materiel areas. Sacramento Air Materiel Area was the principal support depot for Korean operations.

As hard as the command worked, it couldn't satisfy requirements. Combat units complained of the bureaucratic maze established for supply requisitions and equipment authorizations. Further, they said the command relied too much on crash projects rather than smooth and consistent operation. These complaints resulted in the Air Staff initiating organizational and process studies, and these ended in the creation of the Air Research and Development Command and its separation from the Air Materiel Command in April 1951 (235:104).

In review, the Air Materiel Command must be applauded for its support of the Korean War. It did get its mission accomplished even though it had not prepared in advance for it. The quantity of supplies moved into Korea was adequate in the long run although agonizingly short at times. Dissatisfaction with the command management processes resulted in later evaluations and changes, which made the complaints somehow worthwhile.

The War Ends

The Korean War ended 27 July 1953 when the armistice was signed. Many people were disappointed because there was no clear-cut victory. In fact, many people were, and are, of the opinion the United States lost the war in Korea, and this was/is a bitter pill for them to accept. However, the United States and its UN allies did succeed in meeting their objective of preventing the takeover of South Korea by the Communist North.

The Republic of Korea has proven the worth of that investment by its climb in economic strength, role in world affairs, and continued state of freedom. It must be recognized, however, there are arguments about how much freedom the Republic of Korea government permits its people.

At home, the United States also met its objectives. It retained the growing civilian economy concurrent with the growth of military spending and strength. Production goals were met within the times set. Production facilities were built or renovated within the time goals and met their requirements. Industry of all types was expanded. The nation, most importantly, attained a very high state of operational and mobilization readiness for both conventional and nuclear weapons. This caused the Soviets and their allies to alter their behavior at least temporarily (39:67).

However, it is wise to note, again, the United States was not prepared for the Korean War. We did not seem to have plans for national or industrial mobilization. Nor did we have military capability for combat operations in a geographically constrained conventional war. Our military forces went into Korea by direction of the President and did their best in their unprepared state. It was fortunate we had all the World War II surplus in Korea, Japan, and the other islands of the Pacific. Without that immediate support, we might not have been able to remain in Korea. The outcome might well have been quite different. Once again, the lack of logistics considerations in national decisions and the shortfall in logistics planning proved costly.

Chapter Six

The Post-Korea Period

Tensions continued to mount in the world. The major source of problems seemed to be the Soviet Union and its attempts to influence the governments of developing countries and their actions. The US government moved to strengthen its position in the world through stronger alliances. This was significant but costly in resources and assistance.

The United States signed a mutual defense pact with the Philippine government. It signed the Australia, New Zealand, United States (ANZUS) pact on 1 September 1951. That same month, the final peacetime treaty with Japan was signed in San Francisco, and a security treaty was also signed with Japan. In October, the Marshall Plan ended after having saved much of the developed free world from economic and political upheaval destructive of human freedoms.

The United States recognized the threats in a world beset by continuing political conflict with the Soviet Union and its followers. It further recognized the always present danger of war of some kind somewhere. But it also recognized the uncertainty of the forecasts of the events likely to occur. The possibility of war seemed very real in the years following Korea, but there was no reliable means for predicting the what, when, where, or whom of future events. The potential dangers of a new world, in which we no longer had the *two-ocean separation*, were high in the minds of many planners.

National Defense Concepts

So the struggle in the country became one of deciding how to create a military capability and a logistics support system prepared to engage and support any kind of war at any time in any location for any length of time. As always, the advocates of differing schools of thought argued their cases in the news media trying to influence military thinking and congressional action.

The result of the constant threat and the impressed demand for military capability was an array of actions over years. Not all of these actions were compatible, but they all were generally developed to provide:

- Dispersed forces in recognition of the destructive power of nuclear weapons.
- Fast reaction at any time because there was no way to predict when a need would arise. The concept of 15-minute reaction was born in this time based upon the speed of delivery of nuclear warheads by intercontinental ballistic missiles (ICBM).
- A high degree of invulnerability for support services and facilities since they would, theoretically, have to survive nuclear war and still be able to support our military forces.
- All of this capability was to be obtained within the constraints of congressional funding allocations, which would and could be supported by the citizens.

President Dwight Eisenhower announced his *new look* for defense in 1953 and obtained congressional budget action for more than $40 billion. The new look placed heavy emphasis on nuclear and strategic air forces with approximately half the defense budget going to the Department of the Air Force and another heavy portion to the Navy's nuclear capability. Following this line of thought, in January 1954, Secretary of State John Foster Dulles announced the country's massive retaliation program. This, he said, was based on the thought the United States might not in the future restrict itself to local hostilities, as in Korea, but might strike the source of aggression wherever that might be.

The Air Force adopted the *Force-in-Being* concept in 1955 with the basic assumption the next war would be totally nuclear, immediate, and fought with the forces, weapons, and materiel then on hand. The concept called for achievement of a constant state of readiness, with logistics in place, for deterrent purposes and to provide massive retaliation capability (235).

However, this was not reflected by Air Force actions for industrial readiness or mobilization planning with industry. From 1958 to 1967, the Air Force did no industrial readiness planning with industry other than that which naturally occurred through ongoing procurements (39:67). The Navy followed somewhat similar procedures neglecting industrial readiness.

All of this gave industry strange and mixed messages. The Army was actively trying to accomplish industrial mobilization planning with industry. The Air Force and the Navy, though, seemed to be saying industrial mobilization and readiness planning was unimportant. In many instances, the contractors getting this kind of message from the Air Force or the Navy were simultaneously getting the stronger and more insistent messages from the Army. This removed much of the eagerness for industrial mobilization planning from industry because Air Force and Navy views seemed to be the more powerful and more influential view guiding defense policy.

Further, industry was confused because the National Security Council's views were well known, and these views said that strong conventional forces were essential to avoid nuclear war. Industrial mobilization was expensive for the contractors. They did not want to spend their money only to

find the expenditures were neither wanted nor necessary. The result of all this was reduced military preparedness for anything but nuclear war. (39:67, 235).

To reflect this status, it must be noted that the major growth in this period was of the strategic nuclear forces of the Navy and the Air Force. This included the formation of the Joint Strategic Target Planning Service (JSTPS) collocated with Headquarters Strategic Air Command (SAC) at Offutt AFB, Nebraska. The JSTPS, controlling nuclear force assignments, was manned by personnel from all Services and by personnel of our major Allies.

Further, in October 1957, SAC began its dispersal of bomber and tanker aircraft and, also, its one-third ground alert (114:64). Under this concept, whether operating from dispersed or home bases, one of every three SAC bombers was fully armed and serviced from immediate takeoff and sitting on ground alert. The flight crews and support maintenance crews, along with security police and supply and communications services, were in nearby shelters ready for instantaneous response to an alert. Naval nuclear forces were in similar states of readiness.

The following year (1958), the first SAC intercontinental ballistics missile (ICBM) wings were activated. SAC also began a long series of airborne alert tests and exercises (114:73-6). For a number of years following this, the command kept a given number of nuclear armed aircraft constantly in the air around the world flying patterns compatible with their war mission assignments. A fresh aircraft took off before the old one landed, so the coverage was constant. The effect of all this on the logistics support system was significant because of the need for changed and more intensive supply, transportation, engineering, and maintenance support.

In 1961, President John F. Kennedy announced his *flexible response* policy for defense. This brought heavy emphasis for the ICBM forces of the Air Force and Navy, emphasis on the Navy's nuclear submarine forces, and the creation of expanded Army special forces capability. The new emphasis gave heavy news coverage to the Army's *Green Berets* and their military capability and training.

That same year, a book was published that had great impact on defense, logistics, and military thinking. The book, *The Economics of Defense in the Nuclear Age*, was written by two researchers and economists of the RAND Corporation, Charles J. Hitch and Roland N. McKean. This book became a text for the Industrial College of the Armed Forces, Naval War College, Army War College, Air War College, and Air Force Institute of Technology. It affected the thinking of literally thousands of senior officers and civilians and changed the way of doing business in defense procurement, logistics, and operations. It emphasized the systems analysis form of management relying heavily on quantitative skills and data. Its use in the classes of these schools further influenced the thinking of a great number of military officers and senior grade civilians who would be progressing into senior command structures in short time. The effect was long term and strong throughout the Department of Defense and, for that matter, the whole federal government structure.

The Department of Defense adopted flexible response as its new guidance policy. It initiated actions to ensure the United States would be prepared for any kind of war or conflict, conventional or nuclear, of any duration or scale. This caused the Services to reexamine their industrial mobilization planning, no matter how active, in light of the new direction. The Services now had to also redefine stockpile policies and guidance as well.

The new policy created the *limited war* concept, which forecast a conventional war fought outside the boundaries of the United States. The basic thought became mutual deterrence. Both the United States and the USSR had sufficient capability to destroy each other. Both knew that. Neither wanted to start a conflict with nuclear weapons because such war might well mean the end of civilization and certainly would mean the end of the two countries. Therefore, the United States believed war would probably only come in limited form on the territory of a Soviet satellite or neighbor of such satellite. The new limited war concept resulted in the Office of Emergency Planning developing the Resource Mobilization Plan for Limited War in 1966, which included war and price stabilization, price control and industrial mobilization, among other actions necessary when/if war were to come (39:68).

Weapon System Acquisition

Much thought was given to a means for improving the creation and sustaining of military capability. In 1953, the Air Force adopted the weapon system concept it had been developing for several years. Logistics studies of the late 1940s and early 1950s had repeatedly advocated the concept. The idea was to look upon and manage weapons of war as systems rather than collections of components. In many of the studies, a weapon system was defined as:

> A total entity consisting of an instrument of combat, such as a bomber, submarine or guide missile, together with all related equipment, supporting facilities, and services required to bring the instrument to its target or to the place where it would accomplish its mission.

With this concept, a weapon system could be procured having only one contractor responsible for the design, development, and production of the system. Subcontractors would be responsible to the weapon system contractor. The single point of responsibility for a weapon system could react and respond more decisively and rapidly than could the numbers of contractors previously having simultaneous responsibility. Further, in the service, a system manager would have the same opportunities and could provide faster and greater responsiveness to decision or policy requirements.

The idea of single-point production and management responsibility for weapons systems was reinforced by recent production experiences of the Air Force. For example, the B-36 aircraft was then in production at the Convair Fort Worth plant. It was developed and was being produced under the then current philosophy of individual component development and production.

Many separate contractors were involved, and most felt responsible only to the Air Force, not to Convair. However, Convair was the airframe contractor and was expected to assemble all those separately developed components (thousands of them) and make the end system conform to contract specifications. This meant almost every item had to undergo modification varying from only adjustment, in some instances, to major design change or remanufacture in order to fit and function as required. The system was out of control (234:10).

Standardization

Coupled with the weapon system concept was the recognition of increased need for greater standardization of parts, components, and systems in the Services. Again, things seemed to have gotten out of hand. The haste of World War II had created a great number of individual items to meet massive needs of that war. Much of this was unique and still in service or in stockpiles. It was difficult and expensive to support and added greatly to the difficulties of supply, transportation, and maintenance.

> For example, in the Air Force, a 1957 study by the Air Materiel Command discovered 594 different type, model, series of diesel-engine generator sets in the inventory. The study further found that only 38 functionally different generator sets were actually required for Air Force missions.

Obviously, some form of standardization was needed because standardization would:

- Simplify logistics support.
- Reduce the number of line items in supply and the pipeline.
- Lower costs due to the economy of mass production.
- Save money by permitting larger quantity purchases.
- Reduce maintenance and operational training and technical manual requirements.
- Provide higher operational effectiveness.

Actions by the individual Services to obtain standardization were slowly effective. In April 1962, the Department of Defense published the first of a string of manuals: *Defense Standardization Manual*, M-200-A. That manual, revised a number of times, served well to solve a mean problem of logistics.

The Intercontinental Ballistic Missile

Development of the ICBM progressed in both the Air Force and the Navy during the 1950s. In July 1954, the Air Research and Development Command created the Western Development Division. The purpose was to have a responsible agent for managing the ICBM program of the Air Force. It was also designed to create the programs necessary for initial siting, operation, logistics, and training of operator crews and maintenance personnel for these weapons systems.

A year later, the first ICBM logistics plan was produced. It required:

- Maximum use of electronic data processing.
- Minimal stock levels.
- Minimum pipeline time through increased use of air supply.
- Direct support from source to user with minimal storage en route.
- Minimum administration at the operational level.
- Optimum use of contractor maintenance (234:56).

The growing evidence of very rapid development of the Russian missile program increased concern at high levels about military readiness. This concern led, in September 1955, to Presidential approval of a National Security Council recommendation to give the ICBM program highest national security (154:14-16).

The ICBM brought with it new logistics requirements. The operational philosophy involving the ICBM is one of immediate response capability. Immediate response demands full, constant, reliable readiness. The ICBM was different than the aircraft weapons systems. The aircraft could often be launched with a system, component, or subsystem either not functioning or not fully functioning and still accomplish its mission. In other words, the aircraft and its on-board crew could, to some extent, overcome certain system or component faults. The ICBM could not. It could not leave the ground if everything was not working as specified because there was no means for in-flight correction or adjustment of a malfunctioning system or component. Further, unlike the aircraft, the ICBM had no recall once launched. Additionally, the missile had to be able to function within that magic 15-minute response time.

All of this intensified the systems management approach. In the case of the ICBM, this introduced the use of associate contractors with coequal responsibility for one or more specialized segments of the missile such as the airframe, propulsion, or guidance subsystem. Also, the system management approach accommodated the awareness that this weapon was a fixed-site weapon. It had no mobility. All support would have to come to it, and there could be no parochial interests allowed to slow or stop support. Further, in all likelihood, the missile sites would be quite remote from home base. All support would have to travel long distances to reach or service the missile system, thereby increasing the need for coordination and scheduling of effort between support elements.

Maintenance and supply for the ICBM wing became, for practical purposes, one organization. Maintenance had to become primarily mobile teams. Teams of specialists were dispatched to do component replacement on the missile or support equipment onsite. Little or no onsite repair was done because the missile weapon system couldn't be out of capability for immediate launch for the reasons of readiness earlier stated. Supply became extremely important for ICBM system

effectiveness and economy because most spares were very costly, were few in number, and could not be left unserviceable for any lengthy period. In recognition of these conditions, the ICBM maintenance plan called for elimination of the field level of maintenance retaining only the organizational and depot levels of the traditional Air Force structure.

The Logistics Service

Debate that had been started in World War II about the value of a separate logistics service, the so-called *fourth service*, continued and, in fact, grew more concentrated. Many studies of logistics organization and procedures were conducted by students in the military war colleges and by contract research agencies. A great number of questions were posed, but few positive answers were provided by this research. The driving force of the debates was the perceived waste and duplication of effort among the Services (65). A basic question was whether the faults were caused by organization or caused by too much or too little centralization.

During World War II, the Army and Navy together had 26 separate storage and distribution systems. Some consolidation occurred then, and there was a good deal of coordination for the supply and storage of items such as petroleum products, ammunition, and the like. But it took the National Defense Act of 1947 to cut the storage and distribution systems to 12. The Second Hoover Commission in 1955 recommended consolidation of supply. Congress wanted integration of supply and service functions in what would have been a fourth service. The Department of Defense pointed out its progress in streamlining its many supply systems but did not do much to create the integrated functions (213:181).

In early 1956, Secretary of Defense Wilson announced his single manager plan in which the responsibility for managing the supply of a specific commodity or class of commodities would be assigned to a single service secretary. The responsibility would include requirements determination, purchasing, storage, and distribution for all Services. He had in mind meeting the requirements of the Second Hoover Commission without changing DoD organizational structures. Each such single manager would be authorized to collate requirements from all Services, move stocks from one to another, and decide how and when to procure.

All the Services objected to the plan because they seemed to feel they could not trust another service to adequately understand and meet their needs. Congress liked the idea though, and the single manager notion ultimately became DoD policy. The single manager assignments went to the Army and the Navy because both Services had extensive experience with classes of commodities such as foodstuffs, petroleum, medical, or fabrics and clothing. None of the single manager responsibilities were given to the Air Force because the Air Force had no experience with these commodities, having always depended on the Army or the Navy for them.

All service-peculiar supplies were omitted from the single manager assignments. Therefore, no other service would be procuring and supplying ship supplies for the Navy, for example. The system worked effectively and did seem to improve and increase interservice coordination, at least for these commodities, but it did not silence the frequent and continuing calls for a fourth service (213:171-197).

The first Hoover Commission in 1949 resulted in the creation of the General Services Administration (GSA). The GSA was charged to supply all common supplies for the federal government. In addition, the GSA was to own and manage most federal government buildings and facilities for general use. Exempted by the law was the Department of Defense if so desired by the Secretary of Defense. Over the years, much of the responsibility for common housekeeping supply of the DoD has been assumed by GSA. In general, there have been no major complaints of inadequacy of that supply support.

In 1950, the military departments began local purchasing through existing GSA open-ended contracts. This action resulted in reducing central procurement of common housekeeping supplies by the departments and greater reliance on GSA. The service supply depots could then avoid some warehousing, stocking, and inventory management responsibilities and concentrate on their military supply tasks. Further, this would prevent filling the distribution pipeline with items commercially available and commercially distributed in most areas of the United States.

As earlier mentioned, the second Hoover Commission recommended the consolidation of defense supplies. Other studies in the 1950s recommended similar action. Driven by congressional and other forces outside defense, Secretary of Defense Robert McNamara, as one of his first acts, appointed the Vance Committee to explore this problem of supply. The intent was to find more economic means for supplying those items common to more than one service. The Vance Committee submitted a report in July 1961 giving advantages and disadvantages of three plans (the committee was not supposed to make recommendations). The three plans were, briefly:

1. Continuation of the single manager responsibilities assigned the Services.
2. A single consolidated supply agency organizationally assigned to one service.
3. A single consolidated agency organizationally located outside the Services and reporting directly to the Secretary of Defense.

Secretary McNamara announced his decision to employ the third plan beginning 31 August 1961. The new agency was titled the Defense Supply Agency (DSA). Assigned to it were:

- The existing and future single managers for supplies.
- The Military Traffic Management Agency.
- Surplus sales offices and sites.
- Materiel inspection.
- The distribution system using already existing supply facilities.
- Cataloging.
- Standardization
- Coordinated procurement.

The agency still functions today, although the name has been changed to the Defense Logistics Agency, and some responsibilities have been added.

Single-Manager Airlift

Military airlift was another single management problem of long consideration. A single airlift command had been urged as early as World War II, and a variety of recommendations came from a number of study committees and interested agencies. One action, in 1948, had created the Military Air Transport Service from the old Air Transport Command and Navy Air Transport Service. By middle 1954, MATS was providing 50 million-ton miles a month to all Services, but that still was not enough for all their needs. The Air Staff recommended MATS become the single manager for all airlift and that airlift be operated on an industrial fund concept. The industrial fund idea would mean each service would pay for its airlift provided by MATS and MATS would in turn use that money for its operations.

In December 1954, at an Air Force Association Air Logistics Conference, General Nathan F. Twining emphasized the need for larger, faster, specially designed airlift aircraft. At the same conference, Lieutenant General Doolittle, emphasized the need for airlift in the logistics systems and added:

- The need was for an in-being logistics system to support all of DoD.
- Such a system was economically feasible and would save time and money.
- Specially designed military airlift aircraft were necessary.
- Combat forces could only be as effective as the logistics support permitted.
- Airlift aircraft could put the United States in international aviation leadership.

DoD Directive 5160.2, 7 December 1956, assigned single manager responsibility for military airlift services to the Secretary of the Air Force. The other Services were directed to eliminate duplicative services. Industrial funding would begin 1 July 1957. At this time, the Navy was operating its fleet logistics air wings and continued to do so for some time, although gradually phasing out in favor of MATS support.

LOGAIR

Authority to continue to operate outside of MATS a unique cargo operation, known as LOGAIR (logistics airlift), was given to the Air Force. LOGAIR resulted from studies by the Air Materiel Command in the early 1950s in response to its recognized need to be economical and yet have improved responsiveness. These studies showed a contract cargo airlift could work effectively moving critical items and high-value parts from depot to airport of embarkation at lower cost than standard available commercial transportation.

The service began in February 1954 as *Mercury Service.* That name was soon changed to LOGAIR because *Mercury* was in use by a commercial carrier and that carrier did not want duplication. LOGAIR made five round trips a week principally supporting SAC's high-priority needs for aircraft support and support to the growing ICBM operations. The guiding though behind LOGAIR was to have increased readiness for a potential D-day as well as day-to-day improved supply support (235:114-116).

The LOGAIR operation brought in a number of new problems, which over time were solved. The problems were:

- Increased need for coordination of shipments.
- Increased communication requirements.
- Better and more ground-handling equipment and procedures at all ground stops.
- Better and more materiel-handling equipment at all ground stops.

Over time, LOGAIR greatly increased its cargo routing and flights. It also expanded its support service beyond that original service primarily to SAC support.

Airlift—The C-130 Aircraft

We have mentioned logistics heroes of earlier times such as the world-famed *Gooney Bird* (C-47), the Jeep, the 6x6 truck, the Liberty ship, and the DUKW (floating truck). These were all of prime logistics importance of an earlier technology. In the early 1950s, the Tactical Air Command stated a need for larger, more modern airlift, and the C-130 evolved. The Lockheed *Hercules* has become a logistics hero in its own right around the world.

The C-130 probably has the record for being the aircraft longest in continued production. It has been in continuous but modified construction for more than 30 years and shows no sign of nearing the end of its string. Since its first flight in April 1955, more than 1,800 of these amazing aircraft have been produced for a multitude of uses and users worldwide.

The C-130 is approximately 98 feet long with a wingspan of almost 133 feet. It has a vertical stabilizer that reaches to 38 feet. The propulsion system consists of four turboprop engines that provide power to lift the gross loaded weight of more than 175,000 pounds up to a normal ceiling of about 33,000 feet. The top speed is approximately 375 miles per hour. Its range varies according to use, of course, but comes close to 2,500 miles for all versions. Its structure provides a close-to-the-ground rear entry hatch, which makes for ease of cargo loading and unloading in the field as well as from modern airports with minimal need for supporting equipment.

The crew size varies between models and use, but the basic C-130 crew is five members. The aircraft can be modified for a surprisingly wide variety of uses. Its basic use is for cargo movement in tactical and combat deliveries. But it has also been used as a gunship and a weather recon aircraft and for medical evacuation, air ambulance, arctic delivery (sometimes ski equipped and sometimes equipped for jet-assisted takeoff),

fire fighting, aerial refueling, special operations, search and rescue, satellite recovery, drone, assault transport, passenger transport, drone launch, drone recovery, low-level penetration, electronic research, research and development, electronic surveillance, jamming, and hurricane hunter.

The Hercules is a widely known, widely used aircraft. It has been flown by forces of the US Air Force, Navy, Marine Corps, and Coast Guard, plus the Forest Service. In addition, it has been employed by more than 50 other countries and a host of commercial users. The famous LOGAIR of the Air Force Logistics Command has for years been operated by contractors frequently using versions of the Hercules in their fleets. It has been a mainstay for a large number of humanitarian efforts as it moved foodstuffs, medical supplies, construction equipment, and medical and government personnel to famine, earthquake, fire, and other disaster areas.

Electronic Data Processing

The introduction of electronic data processing promised great help to all the logistics processes requiring greater quantity, accuracy, and speed in data transfer. Punchcard accounting machinery had been in use by the military services since 1940. But the punchcard procedures were really too slow and cumbersome for the growing data needs. In supply actions, for example, the clogged paperwork systems meant we had greater requirements for stock quantities and longer pipeline times. This added to costs and often reduced readiness because of the lack of supplies.

The electronic computer had been introduced in World War II. It had particular strengths for meeting logistics needs, which often included extensive computations in addition to massive data files. The UNIVAC computer was in use at Headquarters USAF in mid-1952. In 1954, the Air Materiel Command obtained a UNIVAC for requirements support and supply improvement. Similar action was underway in the Navy and Army.

But in all Services, the introduction of the computer met resistance due to probable fears of automation, lack of understanding of the new technology, and absence of faith the computer could be accurate with its vaunted speed. Many high-level managers resisted the computer for these reasons and others. Adoption was slow. All of this was overcome in time though, and the computer assumed a key role in all forms of logistics operations from small unit to major headquarters.

The National Security Act Amendment

Congressional action in 1958 amended the National Security Act of 1947. The amendment provided additional power to the Secretary of Defense, again added to the Joint Chiefs of Staff manning allowances, and provided a system of unified operational commands with each assigned a mission in full accord with national objectives. The unified and specified commands were thus born. That same year, the Air Force and the Army recognized their joint-service responsibilities and jointly published AFM 1-1/FM 110-5, *Joint Action Armed Forces*.

Logistics Planning

Logistics planning was of principal concern to the Services following the Korean War. The Air Force, in 1956, published AFM 400-5, *USAF Logistics Planner's Handbook*. This handbook contained 22 parts, 132 chapters, more than 400 charts and tables, and more than 1,000 references to aid logistics planning.

The handbook provided a view of logistics of a broader scale than is now commonly used. Part of the planning contents, for example, included:

- Medical service and evacuation.
- Research and development.
- Installation engineering.
- Maintenance.
- Supply.
- Transportation.
- Procurement.

A great number of planning factors were included for all kinds of contingencies. Major air commands created their own planning factors manuals to accommodate their peculiar and specific needs for deployment and movement. In 1959, the Air Force handbook was revised and its content reduced to 4 parts and 17 chapters. Eventually, it passed out of existence as unit-level logistics planning seemed to lose emphasis and priority.

Air Force Support Command Structure

On 1 April 1961, the Air Materiel Command became the Air Force Logistics Command (AFLC), and the Air Research and Development Command became the Air Force Systems Command. This action by the Air Staff related to the Air Force adoption of system management concepts. It was designed to enable more rapid development and support of weapons systems with greater dependability. Ten years earlier, the two commands had been separated, and in the interim, there had been a number of joint project offices manned by members of both. But there were continuing arguments about who was responsible for what and when that responsibility took hold.

The new command titles and mission assignments indicated that the logistics responsibilities for systems support were assigned to the AFLC. AFSC was responsible for development and initial production of weapon systems. AFLC was further responsible for all materiel acquired to support systems in the inventory. In addition, after extensive and protracted argument, initial provisioning for new weapon systems was assigned the added responsibilities for management and command of the contract management

regions, all Air Force-owned industrial facilities, and contractor test sites and site activation for the ICBM force (235:151-2)

Supply

In a speech to the Air Force Association's Air Logistics Conference, 16 December 1954 in Washington, Secretary of the Air Force Harold W. Talbott expressed a need for improved supply. He mentioned that in World War II in Europe it took about 106 days to get a requisitioned item through the pipeline. Today (1954), he said, it takes the US Air Forces in Europe 100 days. Obviously, not much improvement. The indication, he said, is that we have a supply system not geared to modern warfare. The need is for a fresh approach because the combat potential of our Air Force can be no better than the logistics system that supports it (235:3)

In partial response to this challenge, the Air Force assigned responsibility for all overseas depot materiel support to the Air Materiel Command. This action relieved the overseas commands of that logistics administrative burden. Further, the Army and the Air Force agreed to change depot support of Army aircraft, and the Army assumed responsibility for its own aviation depot supply and maintenance.

The Air Force urgently needed 11 million square feet of warehouse space and planned to construct it. At the same time, the Army had 17 depots with a total of 20 million square feet of unused warehouse space. Despite a lot of arguments from both the Army and the Air Force, DoD staff arranged the transfer of the unused Army warehouse space to the Air Force. In the doing, millions of construction dollars were saved, and immediate help was provided to solve a growing Air Force logistics problem.

In 1955-1956 the Air Force instituted a supply program called *Hi-Valu*. This program was based on Pareto's law, which said that a small number of a population would cause the greater part of the problems in that population. Studies reflected a small percent of spare parts consumed a major part of the spares budget. For example, in the B-47 aircraft program, 3 percent of the spares equaled 60 percent of the costs. The Hi-Valu system established precise controls for that small number of items, which were very important from a dollars point of view and established lesser controls for lower cost items.

The program established Hi-Valu control officers at each base who worked with the base supply management procedures officer. Hi-Valu items were marked or stenciled to be obvious to all handlers. All pertinent paperwork was stamped with the *Hi-Valu* log as were all crates and storage boxes for the items involved. Hi-Valu training and indoctrination was mandatory for all supply and maintenance personnel. The program served its purpose and netted priority handling and movement (252). Over time, the program lost its emphasis and faded from use, although the concept of high-value priority is still observed.

The Department of Defense began Military Standard Requisitioning and Issue Procedures (MILSTRIP) in July 1962. MILSTRIP standardized all elements of supply requisitioning and issue in the Army, Navy, Marine Corps, and Air Force. It required the use of the same forms in all Services, the same codes, the same priorities, the same label markings, and the same box markings. It replaced 16 other systems then in use and accommodated the growing use of the computer. In addition, it provided for commonality in all the Services and effectively improved supply operations and speed.

MILSTRIP met all its objectives and continues to this date. Its objectives included:

- The elimination of wasteful effort.
- The promotion of efficiency.
- Speedup of supply actions.
- The reduction of costs for supply administration (315).

Navy Development of Integrated Logistics Support

Early in 1960, the Navy, working with McDonnell-Douglas Aircraft Corporation, developed a process to ensure the integrated engineering of all support requirements for an aircraft early in the design stage. This resulted in a project identified as Integrated Maintenance Management for Naval Weapons Systems, which was successfully applied to the A-7A acquisition with Ling-Temco-Vought, later LTV.

Ultimately, this process became the Integrated Logistics Support (ILS) Program adopted for all major weapon system acquisitions by the Department of Defense. ILS required design and production engineers to become involved with post-production logistics support before manufacturing a new weapon system.

However, at the time, the Navy was primarily interested in reducing aircraft maintenance manpower and downtime requirements while simultaneously improving the combat readiness of the fleet aircraft. The Navy's emphasis resulted in the development of the Maintenance Engineering Analysis Record (MEAR), which became the basis for DoD's logistics support analysis (LSA) program outlined later in MIL-STD-1388.

The Navy had discovered that the newer and more complex aircraft showed a trend of decreasing readiness, mostly due to increasing maintenance downtime for various causes. The Navy's work with McDonnell-Douglas and Ling-Temco-Vought was effective and profitable. It resulted in maintenance man-hour and downtime reductions and increased fleet aircraft readiness. It also proved enlightening to design engineers and manufacturing officials. DoD recognized the value of the approach and ILS, accompanied by LSA, became the key to weapon system acquisition logistics (12).

Maintenance

Maintenance continued to be a high cost in manpower and parts to all combat and support commands. Many studies of maintenance were conducted, and as earlier described, some commands were gradually forced to change their maintenance

organizations and processes. SAC went to specialized aircraft maintenance as did the US Air Forces in Europe. In a short time, all Air Force commands went to the specialized approach, and it was effective for its time.

Further, actions were taken to analyze and evaluate depot maintenance requirements. In 1952, the Air Force adopted the IRAN concept of depot maintenance. IRAN stood for inspect and repair as necessary. It replaced the customary complete teardown and disassembly of an aircraft or item of equipment entering depot maintenance. It significantly reduced the cost of depot maintenance in dollars, manpower, and time. For example, the C-47 depot cycle was reduced in cost from $60,000 per aircraft to $13,000 (3:375).

In the 1960s, the Navy adopted a modified version of the specialized aircraft maintenance concept and gave particular attention to the collection and analysis of maintenance data. The directive was the Maintenance Materiel Management Program, commonly called *3M*. It was applied to aircraft initially but soon was extended to other areas of maintenance, including the ship, test equipment, and so forth. A data center was established at Mechanicsburg, Pennsylvania, for maintenance analysis and reports. The program was successful and helpful.

Similarly, the Army adapted the specialized maintenance concept and the maintenance data collection processes for its mission equipment. The system became known as The Army Materiel Management System (TAMMS). The data center for TAMMS was established at the Blue Grass Army Depot, Lexington, Kentucky.

The Air Force, in the 1960s, counter to the dispersal being accomplished by the rest of DoD, began a drawdown and centralization of its depot capability. The overseas depots were eliminated, and depots in the United States were consolidated. The depot functions at Rome, New York; San Bernardino, California; Middletown, Pennsylvania; and Mobile, Alabama, were eliminated. The responsibilities were shifted to the five remaining depots located at Oklahoma City, Oklahoma; Warner-Robins, Georgia; Ogden, Utah; San Antonio, Texas; and Sacramento, California (235).

Naval Support Reorganization

On 1 January 1965, the Navy reorganized to advance effectiveness, responsiveness, and efficiency of logistics support. The naval ship repair facilities in the Pacific Basin and the naval supply depots at the same sites were assigned to the Commander Service Force. So, too, were the naval ordnance facilities, the naval magazines, the Fleet Post Office, and the headquarters support activity, all in the Pacific. This meant that logistics support forces, afloat or ashore, were now under one command. The Commander Service Force was made responsible for full logistics support of the Pacific fleet. Before this action, all these facilities and their responsibilities had been fragmented among the bureaus concerned (113:25).

The reorganization showed that many faults had developed over the years. For example, the Naval Supply Depot, Guam, had a mission assignment directive that did not even mention the fleet or the operating forces. The only support mentioned was that for the command and activities ashore. This was immediately changed, and fleet supply items were added to specially tailored inventory to meet the needs of growing numbers of ships home ported in Guam.

While not part of the reorganization, it should be mentioned that in this timeframe the Navy's insistence on common procedure also paid off. Thus, in areas such as supply and maintenance for ships, aircraft, or ordnance, the Navy throughout the world, ashore and afloat, had the same consistent systems and procedures. A man trained to do his job one place was ready to perform a similar job elsewhere with minimum adjustment (113:26).

The Cuban Missile Crisis

There was growing concern in the early 1960s about Soviet intentions and actions in the Americas. Increasing intelligence indicated that they were positioning strategic bombers and middle-range ballistic missiles in Cuba just 90 miles from the shores of Florida. This was intolerable to the United States, and it violated the long-held US policy of the Monroe Doctrine that kept European powers from establishing bases in the Americas. The Soviet offensive weapons in Cuba presented a threat to US cities and defense installations and to the Panama Canal. We were receiving intelligence about these activities from Cuban refugees, but the Soviets denied our queries about their actions and intentions. The Air Force, with Presidential direction, increased its U-2 overflights, and in October 1962, confirmed with photo reconnaissance the presence of Soviet missiles and the building of missile launch sites. It was obviously a Soviet offensive venture in the Americas.

After long debate and exploration of options, President Kennedy chose to advise the Soviets to remove the missiles and bombers from Cuba and that a naval quarantine of Cuba would begin 24 October 1962. Concurrent with the naval action, all military forces of the United States were placed on alert, and low-altitude reconnaissance flights were begun. SAC dispersed its bombers and tankers and increased its airborne alert. Polaris submarines were positioned on full alert in their war assigned areas. Air defense forces were on alert, and the Tactical Air Command was on alert and deployed in the United States. The Navy was on alert worldwide and in position for wartime functions in addition to its quarantine actions. The Army, along with the TAC wings, deployed strong forces to the Southeastern United States.

There were tremendous demands on the logistics systems for all this military action. Supply, maintenance, transportation, and procurement personnel in all Services worked without rest for days doing their utmost to reach maximum capability and stay that way. They succeeded, and the buildup was perhaps the greatest show of nuclear strength the world had ever experienced.

The Organization of American States approved military force action if necessary to carry out the quarantine. The North

Atlantic Treaty Organization approved US quarantine actions of the United States. The Russians became aware of the growing strength and determination of the United States. On 28 October, Russia agreed to dismantle and remove all the missiles and to remove all strategic bombers from Cuba. This was done by 20 November. The Cuban missile crisis was over, and as in the Berlin Crisis, the Soviets bowed to demonstrated American resolve.

Chapter Seven

The Vietnam War

Problems for the United States in Southeast Asia began with the end of World War II and the release of the countries in that the area from Japanese occupation. Vietnam was one of those countries even though, as a country, it was generally unknown to most Americans. It had earlier been called French Indochina and had been ruled by France for almost 100 years before the Japanese occupation. Vietnam had two internationally recognized governmental elements: North Vietnam and South Vietnam.

When the Japanese occupied the entire country, a native leader, Ho Chi Minh, who had extensive Communist education and background, assumed leadership of the Vietminh and worked with US forces to harry and annoy the occupying Japanese. When the war ended in August 1945, Ho Chi Minh declared North Vietnam independent and separate from South Vietnam. This led to fighting between the Vietminh and the French who had resumed control of the area. Ho Chi Minh continued the jungle fighting in which he had been so successful in World War II.

The French strongly resisted the Vietminh forces and gladly accepted military aid from the United States as offered by President Truman. At the same time, Ho Chi Minh began to receive military and economic support from the new Communist China. Ho Chi Minh was the more successful fighter and had the advantage of appealing to the people through his goal of a unified, Communist-ruled Vietnam. The battles continued for more than 4 years finally ending when the French lost Dien Bien Phu. The Communists had won, and Ho Chi Minh could now proceed to work toward his goal of unification of Vietnam. However, two segments of the country continued to exist.

Constant problems existed between the North and South. Fighting between the two factions was common and sometimes very intense. US military aid was concentrated in equipment and supplies, primarily, although a small number of military advisors were provided the Republic of Vietnam (the South). In 1961, we sent some surplus World War II aircraft to South Vietnam and additional advisory personnel. Small groups of people and quantities of supplies continued to flow to the Republic of Vietnam (RVN) forces from the United States through the next several years.

Major aircraft maintenance for the RVN was being done at Clark Air Base in the Philippines. This soon became a major supply problem because of distance. It soon cost the RVN much lost readiness time, so the Air Force decided to make Tan Son Nhut Air Base in Saigon a main operating base and move some of the supply and maintenance capability from Clark Air Base to Tan Son Nhut. In December 1962, the Air Force Logistics Command assigned Tan Son Nhut an Air Force supply account number (235:158).

The North Vietnamese began active infiltration of the South and initiated subversive actions with the aim of disrupting and destroying the RVN. The US role remained that of supplying military advisors and providing military and economic aid. All the while, the subversion from the North continued, and internal politics of the South boiled and seethed. In August 1964, conditions worsened when North Vietnamese torpedo boats attacked US Navy vessels in the Tonkin Golf (235:159). This incident remains debatable to this day but, at the time, was taken as fact and was immediately followed by US retaliatory raids on North Vietnam.

In January 1965, the US military commitment in Vietnam was about 23,000 men. They were members of the military advisory groups of the Army, Navy, Marine Corps, and Air Force. Offshore, the Navy's Seventh Fleet patrolled the waters adjacent to North Vietnam. The fleet offered considerable logistics support should it be required. But ashore, the RVN was in poor condition. The military situation was deteriorating under the constant pressure from the forces of the North. The condition not only threatened the safety of US advisors but also seemed to indicate that the RVN was close to falling (122).

General William Westmoreland has stated that as late as March 1965 the United States had made no decision on ground intervention in Vietnam. The nearest to that condition was the Marine Corps security force deployed to protect the DaNang airfield. Consequently, there was no logistics system in being at the time and no development of secure logistics bases other than the completely inadequate installations associated with the RVN forces. The ports were inadequate and so were existing airfields. The infrastructure of the country was primitive at best and nonexistent in many areas. There were no logistics troops in country (106:6).

In early 1965, the US government concluded it would have to either pull out of South Vietnam or significantly increase and expand its involvement in the ongoing civil war. The decision was made to remain in the country and continue to assist the RVN in its rejection of the North Vietnamese activities. In February, with no congressional declaration of war or even a Presidential declaration of a state of emergency (39:68), the United States began active participation with aerial bombing of North Vietnam in an operation called *Rolling Thunder* (235). In March, the two US Marine battalions went ashore at DaNang. In June, President Johnson approved US

troop involvement in ground combat, the use of TAC fighter support in country, and strategic bombing support by Strategic Air Command under Operation Arc Light.

Once again, we entered war with no buildup time. The logistics problems, for quite some time, stemmed from this. There were no logistics staff and no logistics organization in country or available for deployment to Vietnam. What existed in logistics was overwhelmed for years as the US involvement in Vietnam grew.

The Vietnam War was quite different than that for which the Army and Marine Corps had been trained. It also turned out to be different than the strategic, tactical, and logistics planning envisioned for US forces. The ground war was a war of small units in constant pursuit of an elusive enemy. It was different than World War II and different than Korea. There were no fixed terrain objectives in most cases (106:7).

There was no fixed front line and no rear boundaries. There was not a linear division between friend and foe. There was no difference between the combat zone and the communications zone. There were no truly secure installations, ports, or airfields because all were subject to sabotage, sappers, and rocket attacks. Attacks on logistics facilities were relatively common throughout the war. The so-called *clear areas* were secure only in the sense there were no visible enemies close at hand (106:7).

Logistics Problems

Once again, the United States encountered major logistics problems because of the absence of planned logistics support for involvement in a war. None of the Services had adequate logistics support organizations or processes available for in-country immediate use.

In Vietnam, there was no adequate infrastructure for logistics use. The highway system was less than primitive outside the major cities. Ports were poor and always overcrowded. No major transportation system existed. Airfields were generally inadequate or, in most cases, nonexistent. Warehousing did not exist. Cantonment and base facilities were not available. There was no reliable countrywide communication system. Equally as important, the population offered very little in the line of experienced or qualified people for our forces to count on for local support.

In effect, the United States had to begin from square one to build a logistics system in country along with all its necessary infrastructure elements. Fortunately, we were able to extensively use US contractors in country for most of the war, and our civil service personnel were willing to go in country for support purposes. All elements of logistics and all functions of the system were supported by these nonuniformed US personnel plus a good number of third nation citizens on contract.

The Republic of Vietnam was an undeveloped nation in an undeveloped country. Additionally, the population was not fully in sympathy with and did not support the government. Politics provided frequent disruptions and strong animosities. So there were internal problems to be faced concurrent with the problems of a new form of combat for most US military leaders.

The flood of military and civilian supplies and materiel sent to Vietnam from the United States tempted many of the citizens who were very poor. Theft became and stayed a major logistics problem in country. Some of the people of the RVN also became active, although clandestine, supporters of the North and created problems with sabotage, theft, and interference. Assaults from these people and infiltrators from the North continued throughout the war and were costly.

The war was fraught with problems from the beginning. The climate was hostile and extremely difficult to deal with. It caused health problems for many people and added to the medical service requirements. Further, the climate raised havoc with supplies. Rain was often overwhelmingly heavy. Humidity was constantly high. Corrosion, mildew, and rot were principal problems for most all classes of supply. Mold attacked everything and, in some instances, totally destroyed the basic item. For example, combat boots and field shoes seemed to be eaten rapidly by mold.

Insects and rodents were constant annoyances and caused considerable storage problems. It was necessary for the United States to construct huge quantities of covered warehousing to provide minimal supply protection. Several large depot facilities were ultimately constructed by the Services to do higher level maintenance and provide adequate supply support. Even the best of storage seemed unable to defeat the climate and the bugs. Supply losses to the environment continued through our stay in the country.

Early in the war and for several years, much support logistics was accomplished from outside Vietnam adding to the pipeline time. As mentioned, for example, the facilities at Clark Air Base in the Philippines provided maintenance support for RVN and USAF aircraft. Navy support came from Subic Bay in the Philippines as well as from Japan. Army and Marine Corps support came from those sites plus Okinawa. While this was effective, it was also expensive and proved a heavy drain on both airlift and sealift transportation.

Additionally, we diverted equipment from units in the United States directly to Vietnam for combat use. This form of supply was helped by the DoD base closing decision. However, the equipment seemed to arrive in Vietnam sort of helter-skelter with no one knowing with certainty what was loaded where on what ship or aircraft. As a result, the beginning of a long-term problem of *lost* supplies was created. Units in country sometimes suffered because they couldn't get needed things even though those things were somewhere in country.

The buildup of Air Force capability was, to a large extent, dependent on support by the two other Services. Early in the involvement, the Army was providing all central support for common items for all Services. During the buildup, 40 percent of requisitions were *lost* because of poor communications with the major supply support installation on Okinawa. Stocks were not deployed in country in sufficient quantities. Support personnel were not available in the quantities required (196:17).

All fuel supplies were controlled by the Joint Petroleum Office at CINCPAC (Commander in Chief, Pacific) Hawaii. Complications of joint-service logistics caused the Military

Assistance Command, Vietnam (MAC-V) to establish the Distribution and Allocations Committee to control and allocate distribution of supplies for the RVN force modernization and for US units (196:18).

Not all the problems were in country. This was a war fought thousands of miles from the seat of the government of the principal participant. Yet for the most part, the control of the war was held in the hands of the politicians and military leaders far from combat. Political figures and DoD officials made many of the decisions about strategy, tactics, and logistics with insufficient information, little or no military experience, and no knowledge of the current combat environment. No national mobilization was called, the Reserve Forces were not used, and no declaration of war or state of emergency was made. Forces were often incrementally committed with little chance for significant victory. Objectives were frequently changed with little or no coordination and with little or no prior notice to the field commanders. Further, the Department of Defense was, at the time, undergoing several degrees of reorganization with resultant confusion of direction.

At home, the civilian populace was equally confused about the war. Without the general consensus of World War II or the reluctant agreement of Korea, the United States was again engaged in war. This war had minimal impact on the civilian population because industrial mobilization did not occur and it was seldom necessary to invoke any form of priority shift of industrial capability. Store shelves remained full. Jobs were available. Incomes were rising.

The dark cloud was the growing number of US dead and wounded in Vietnam. Many Americans reacted strongly to these statistics. Soon there were student uprisings against the war. Citizen groups protested outside armament plants. Particularly active disagreement was directed against the manufacturers of napalm and similar munitions classed inhumane by the protesters. Some groups became very militant, and there were bombings of facilities and service agencies thought to be primary supporters of the war. Overt expressions of disagreement were common. Some American citizens even visited North Vietnam and made public expressions of sympathy for the cause of the Communist North. It was a rough way to fight a war.

The logistics problems came in many forms. No one really had any idea of the depth of commitment by the United States or the length of that commitment. Therefore, not much extended logistics planning could be done with any certainty. There was, in fact, a great deal of uncertainty. The uprisings at home, the growing clamor of the activists, the student revolts, the absence of a declared state of war or emergency, the failure to call up the Reserves, all led to uncertainty. Then, as in the Korean War, annual budgeting seemed to be done on an optimistic basis. In fact, at onetime, the budget assumption was the war would cease by end of the current fiscal year. This was Korea revisited and with the same no-win result. All of this complicated the problems of providing timely and adequate logistics support (113:4).

The strategy and tactics of the war also affected logistics support. The United States and the RVN exercised a defensive strategy, except in North Vietnam. At the same time, the North Vietnamese and the Vietcong remained almost purely offensive combining politics, propaganda, invasion, subversion, and guerrilla action. All the activity of the North was directed to a strong political objective, which the US and RVN forces seemed not to have or understand (113:4). In fact, various reports indicated that the average soldier, airman, or sailor in Vietnam did not know or understand the reasons for his presence in the country. The objectives of the United States were not openly expressed and certainly were not part of the orientation of the military personnel.

While the US and RVN forces had significant logistics problems, we must not forget that the North Vietnamese also had theirs. They depended almost totally on the receipt of weapons and supplies from Communist friends and allies outside the country. Weapons, aircraft, munitions, equipment, and supplies came from the Soviet Union, its satellites, and Red China. Russian technicians trained and aided the missile force, air force, and ground control forces. China provided logistics and construction aid near the common border with North Vietnam. North Korea provided aviators and other support (113:4-5).

Much of the enemy's support came by rail from China to Hanoi and then by various means of transport further south. This transportation was subject to US interdiction later but always with severe control limitations from outside the combat zone. The greatest bulk of the supporting materiel came by ship through Haiphong. It is reported, for example, that 47 Soviet ships delivered war materiel to Haiphong in 1964. But there were 76 such ships in 1965, 122 in 1966, and 433 in 1967. Most of that shipping was Soviet, but some came from Soviet satellite nations in Europe and from China. Although the United States had the ability to effectively stop this flow of materiel from the sea, it did not do so until late in the war. The decisions from Washington forbid active naval closure of Haiphong port or harbor (113:4-5).

We have mentioned the great distance from the supply source in the United States to Vietnam. That, too, was a logistics problem complicating the waging of war. The distance was made a far larger problem by the unforeseen heavy usage of war materiel, far more than had been required by our forces in earlier wars. Supplies, munitions, equipment, and materiel quantities far exceeded those of World War II or Korea (113:6). Later in this chapter, we will mention the vast increase in demand for munitions, for example.

When the war started for the United States, there was only one major deep-draft port in the RVN. That was Saigon, and it was limited by water depth and pier space. The only other port that could accommodate oceangoing ships was Cam Ranh Bay. It had only one small pier. Anywhere else on the coast, initial dependence had to be almost entirely on logistics-over-the-shore employing unloading over the side onto lighters for movement to shore (113:7).

Since logistics includes the living and care facilities, we must consider that phase of the support. It is extremely helpful to the logistics manager to know just what will be the theater of operations standard of living for troops. The standard should

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determine construction standards and degrees of permanency of cantonment buildings, messing facilities, medical facilities, and so forth. Further, the standard should state whether base, ship, or post exchanges will be required and, if so, to what degree. What form and capacity should the utility services take? Obviously, there are many other questions, but it should be recognized these are essential construction requirements for effective logistics support (106:17).

Without such standards, the logistics systems have no grounds for challenging any requirement imposed upon them. The standards were never established in Vietnam except in part late in the war. Therefore, every unit independently established its own standard of living. General Heiser has stated the units ordered from the supply catalogs as if they were Sears and Roebuck catalogs (106:17). Those commanders who wanted to could and did order almost every conceivable nicety, giving their people the highest quality of living comfort. Often, this included air-conditioning, refrigeration, and other excessive requirements, which, on their own, then added to the support load for maintenance, utility services, supplies, and so on. It was, in fact, a mushrooming effect.

The logistics tasks were not easily accomplished. Progress was made, but it was not always smooth, efficient, and economical. On the contrary, the logistics effort often seemed to lag behind the demands for personnel, money, facilities, and equipment. Nevertheless, the logistics systems did work effectively. Field commanders and individual troops indicated in various ways that, with minor and short-term exceptions, their needs were met to a high degree. The faults we find as we complete our exploring of the logistics of this war should not obscure that fact. The logistics system did meet the objective of supporting the troops in combat (122:4).

Industrial Mobilization

As had happened in the past, in the period between the Korean War and our buildup in Vietnam, the American military industrial base had generally fallen apart. Civilian production was doing well, but the only military activity was in those industries meeting current and continuing defense contracts such as those for aircraft, certain vehicles, some communications gear, and similar equipment and supplies. The others, devoting their efforts to civilian goods, had no incentive to work war materiel under defense contracts. Further, as the opposition became more vociferous, some manufacturers decided it was to their long-term benefit to refuse defense contracts.

Without the declaration of war or a declaration of a state of emergency, we had no legal means to force production of war materiel. We had to convince contractors or do without. It made for a tough time for the procurement people—particularly those responsible for munitions acquisition, which seemed to be the focal point of much of the demonstrations by the activists. Research and development, especially in universities, was similarly affected, and we suffered from the technological delays later.

Procurement and receipt of equipment and supplies lagged behind the Vietnam manpower buildup. There was not always enough materiel to meet all worldwide requirements. The condition required great managerial skill of key logistics people as they struggled to keep the combat forces fully supplied without creating dangerous shortages elsewhere. A good quantity of materiel was taken from Reserve units to be shipped to Vietnam. In the case of the Army, tight central control of certain supplies was found necessary to solve the problems (106:28).

Production problems stemmed from a number of causes. Already mentioned was the wide reluctance of manufacturers to accept defense contracts or give those contracts priority. The national philosophy was to assist the RVN with military personnel and equipment while concurrently maintaining a full, uninhibited civilian economy. Consumption was growing, incomes were up, and civilian demands were high. Without some national focus on the needs for war equipment and materiel, the industrial base was unable to meet all our military needs in a timely fashion.

Another problem was the planning assumption that the war would end before 30 June 1967. This created a condition very much like what we mentioned in support of the Korean War. Budgets and procurement contracts were created on that planning assumption. Because of production lead times, many producers saw they would be reaching peak production, at their high corporate expense, just when the need for their

products would be declining. They just were not interested in that sort of business. 9106:28).

Many military items had only a single source of supply in our economy. The sole source was a hindrance to rapidly increasing the production of new quantities of the items. Very often, the sole source just couldn't increase its production enough or fast enough to meet our rapidly rising military requirements. Other producers could not be convinced to put the money into production capability for these items and have only short-term use for that new capability (106).

A number of the needed industrial plants for munitions were government owned because the products had little or no civilian market. Just before US involvement in Vietnam, the Army's munitions plants were not being fully used. In fact, as the buildup began, only 11 of 25 such plants were in operation. The others were in caretaker status and not ready for production without a lot of effort. By 1968, all but one of the munition plants were back in production. Additional help was given the munitions problems by the creation of special management offices to control them. The first such office was an office in the Department of Defense for air munitions. This was soon followed by a similar office in Deputy Chief of Staff/ Logistics, Department of the Army for ground munitions. These control agencies were effective in managing the high-cost munitions efforts (106:30).

Logistics Planning and Manpower

Before the war in Vietnam began, the Commander in Chief, Pacific had developed detailed operations and logistics contingency plans for potential involvement of US forces in that country. The plans identified the shortages and limiting factors likely to be encountered but did not provide for followthrough actions. The result was a failure to correct the identified shortfalls and problems. Those problems and shortfalls existed when US troops were committed. The logistics inadequacies, including some of those already mentioned, were known but not corrected, and no action was taken to modify plans to live within the constraints caused by them (122:5).

The planning process did not provide for positive followthrough to ensure programming and budgeting support of long lead and critical items such as mobile piers, barges, lighterage, heavy construction equipment, and other materiel peculiar to the theater contingency plans.

The recognition of these problems in 1965 was too late to be effective. The failure to act earlier had a significant effect on port throughput capacity, sea and aerial port congestion, inadequate storage facilities, and loss of materiel (122:5).

Had logistics planners recognized these problems earlier, they could have acted to ensure planning to live within the constraints until they were corrected. This might have meant some reductions in combat troops and changes in deployment schedules. But it would also have meant earlier emphasis on port development and a concentration on essential supplies rather than the *freewheeling* ordering that occurred. Many of those freely ordered quality-of-life items inundated port clearance authorities and exceeded depot receiving capacities.

The Air Force logistics effort and planning was established by the direction offered in four operational decisions in 1965 (196:18). They were:

- Approval to use jet aircraft to support the Vietnamese Air Force (January).
- Strikes on targets in North Vietnam (March).
- The use of the B-52 aircraft for conventional bombing (June).
- To change the status of deployed forces from temporary duty to permanent change of station (September).

Initial Air Force support employed the forward-operating base/main operating base (FOB/MOB) concept. Support for the temporary forces was provided offshore in Japan, Okinawa, and the Philippines for major scheduled and inspection maintenance of aircraft. However, when the decision was made to make deployment a permanent change-of-station move, each FOB became self-sufficient with operations patterned after wings in the Continental United States. The transition from FOB to MOB was complete when all support functions were available at the MOB and lines of communication were opened with depots in the United States (196:19). Supply support initially came from the supply element at Clark Air Base, Philippines. But that could not work with the increased requirements, and eventually 16 new and separate supply accounts were established in country with initial stockage from US depot resources.

Army and Navy planning included depot support in country. The Army planned for two major base depots and five support commands. The Navy planned on supporting ships and vessels plus the ashore facilities in the Saigon area. Army depots were planned to have a 45-day supply level, and the support commands would have 15 days. Navy planning was similar.

The government's decision not to call up Reserve Forces also made planning very difficult. So, too, did the continuing congressional and DoD ceilings on the numbers of people allowed in Vietnam. When the number of combat forces increased, the ceilings dictated either reduction of support forces or long, slow actions to obtain authorization for larger numbers of people in country. Thus, the increased use of ground combat forces generally meant fewer logistics people even though the increased numbers of combat troops meant increased support requirements. Each time a new in-country manpower ceiling was established, it was announced as the final ceiling and could not be changed. All planning had to be done on that basis. Therefore, logistics planning quickly became *too late planning*. But even worse, all requirements determinations also became too late. This all affected procurement lead times, distribution, and stockage. It should be easy to see such decisions also affected draft quotas back home, planning for recruit training, and on and on. The changes in in-country personnel are reflected in Table 8 (106:13-14).

Date	Personnel
31 Dec 60	900
31 Dec 61	3,200
31 Dec 62	11,500
31 Dec 63	16,300
31 Dec 64	23,300
31 Dec 65	184,300
31 Dec 66	425,300
31 Dec 67	485,600
31 Dec 68	536,100
31 Dec 69	474,400
31 Dec 70	335,800
9 Jun 71	250,900

Source: (106:14)

Table 8. Total US Military Personnel in Vietnam

A further problem for logistics planners was the decision to fight the war with personnel on short tours to Vietnam. Unlike World War II when troops were sent overseas with an unspecified return time (usually known as *for the duration*), the troops went to Vietnam knowing they were returning to the United States in 12 months. Thus, there was always the turmoil and disruption of turnover. The quick turnover also was disadvantageous to cohesion and esprit in the units. It seemed the leadership had learned little from the experiences of our earlier war.

The 1-year rotation created continuing problems. It was generally believed the person spent the first 3 months in Vietnam learning his way around and getting acclimated. Then the person might have 6 months of productivity followed by a final 3 months getting ready to go home. Because the date for return home was known far in advance, a person could become very self-protective in those final weeks. He could try to avoid any effort that might make return impossible or endanger himself. While this may sound harsh, it must be considered as a practical and real problem for this form of troop employment. It certainly added to the logistics problems.

Further, there were strong efforts made to provide each person *rest and recuperation (R&R)* about mid-tour. *R&R* was rest and recreation or rest and rehabilitation. Most of the personnel took it as a promised right of the tour. It meant the individual left his unit for at least a couple of weeks traveling at government expense to Hawaii, Hong Kong, Australia, or another attractive place. A return to the United States was generally not authorized. The R&R effort added to the nonproductive time of the tour and consistently created manpower and workload problems as well as financial and transportation problems for the command.

Many of the personnel policies of the Vietnam War were in contradiction to the rule of war, which states:

> There is a point in the lines of communication behind which the maintenance of forces is relatively simple and straightforward. Ahead of that point, though, the maintenance of forces becomes quite difficult, complex, and demanding.

Therefore, logic would suggest we should not advance an organization or a piece of equipment beyond that magic point if that organization or piece of equipment, is not essential to combat operations underway or planned. We cannot afford to have nonessential people or equipment on our support backs in a tight combat zone. That rule and that logic were not observed in Vietnam. We have mentioned the *Sears and Roebuck Catalog* ordering of niceties.

We must also cite the Olympic-sized swimming pools, the air-conditioned quarters, lighted ball diamonds, large exchanges, and recreation people assigned. All of this created need for more support—that mushroom, again. Some have suggested this caused us to have three people supporting every one person in or subject to being in combat. We could not afford this and cannot afford it ever again.

The absence of deployable military logistics support units created a need for competent manpower that could only be met through the use of contractor and civil service personnel. We used great numbers of them for construction, base facilities maintenance, depot operations, port operations, data processing, and many other logistics support duties. We should be very proud of the willingness of these people to serve in combat areas and to serve for long periods. However, we did experience shortages in country of qualified people to administer and guide contract activities.

Medical Support

The Navy medical personnel provided care for thousands of military and civilian officials in the Saigon area and the southern portion of Vietnam. The hospital had more than 100 beds. It was manned with 9 doctors, 16 nurses, and more than 80 corpsmen. A helicopter landing area was provided for the receipt of those wounded who were air evacuated from the combat activity. A large dental facility was also provided, and dental care exceeded 12,000 patients before the end of 1965, for example (113:65).

The Seabees constructed a 400-bed naval hospital in DaNang. It was built of Quonset huts and walkways. Most of the construction materiel was World War II residue. The hospital, therefore, closely resembled a World War II hospital but with more modern equipment. Construction was not uneventful. The Vietcong sappers placed chargers against the first 200-bed increment in October 1965 and seriously damaged it. The hospital was completed, though, and continuing Marine security was provided. Later, a preventive medicine capability was added, and intensive care capacity was increased.

Communications were established so the hospital could coordinate the movement of wounded and ill to other care facilities and the hospital ships. This was done to increase the efficiency of the hospital and enable it to more readily provide initial care. The hospital grew in size as the war progressed. The monthly patient admission load was soon running more

than 1,300 people with a peak of more than 2,000 in February 1967. The Tet Offensive in 1967 led to daily admissions exceeding 160 patients.

Hospital ships spent most of their time off the coast of DaNang. Many patients were brought aboard these ships by helicopter, although lighter service was also employed. After 1967, there was always at least one hospital ship offshore. Surgical teams from the ships were provided to amphibious ships for duty in assault operations. They performed similarly to the Army's MASH and provided onsite, immediate, emergency medical care to the wounded (113:77).

Army and Air Force casualties received the same excellent care. Army records reflect that in the Vietnam War only 2.5 percent of the wounded who reached a medical facility died. This was much better than World War II, which experienced 4.5 percent deaths under the similar circumstances. (As a matter of interest, the rate in World War I was 8.1 percent, and in the Civil War it was 17 percent.) The higher survival rate was principally due to the fact the wounded reached their initial medical care alive because of helicopter removal from combat. The helicopter ambulance was a real lifesaver (106:213).

Medical service in Vietnam was as good and as complete as that found anywhere in the world. It included evacuation, hospitalization, dispensary, dental, veterinarian, laboratory, and research. Cross-servicing was extensively used. The Army, Navy, and Air Force assumed patient care for any patient regardless of service affiliation. The cross-service and the helicopter meant that by 1968 any casualty evacuated by helicopter was within 30 minutes of a hospital capable of providing definitive surgical care (106:213). The number of patients moved by Army air ambulance is shown in Table 9.

Each time a patient was moved by helicopter, he or she was counted as an evacuation (106:214).

The hospitals were designated permanent in so far as siting was concerned. They would, therefore, be provided permanent construction support and the needed security. Those areas of the hospital designed for preoperative, operative, postoperative, and intensive care were air-conditioned. This was a necessity in the Vietnamese climate with its high temperatures and high humidity. The medical administrators attempted to keep 40 percent of the hospital beds empty at all times to have capacity for the sudden surges of casualties that occurred from time to time.

In addition to combat casualties, the medical services had to provide medical care for normal illnesses, emergency illnesses, accidents, and diseases. These constituted more than 80 percent of the patient load for the Army, for example. The diseases were primarily malaria and other fevers of unknown origin, respiratory ailments, skin problems, and diarrheal diseases. Malaria was exceeded only by wounds and nonbattle injuries as a cause of man-days lost from duty (106:214).

Year	Number of Patients
1965	11,000
1966	65,000
1967	94,000
1968	206,000
1969	241,000
1970	197,871

Table 9. Evacuation by Army Air Ambulance

Medical supplies were handled by medical depots and hospitals. These systems were separate from the other supply systems. They were dedicated to customer/patient service and did their jobs with skill and dedication. Medical logistics was a shining star in our Vietnam War experience.

Procurement

The procurement and production contribution to logistics support of the Vietnam War occurred under unusual circumstances, which impacted significantly on its performance (124:16-3). The value of contracts awarded annually jumped from $28 billion in fiscal year 1965 to $45 billion in fiscal year 1967, the peak year of the effort. But procurement organizational structures through that time were undergoing major changes, new constraints were being applied, and military purchases had to compete with civilian orders for available production capacity. In addition, the continuing fluctuation in requirements made procurement even more difficult.

The decision was to use competitive procurement to the maximum extent to reduce the cost of the war. While this might have been a valid consideration for the time, it turned out to be a bad decision. It invalidated all the planning agreements the Services and DoD had made with industry. There was to be no industrial mobilization (39:69). Further, a decision was made not to impose wartime controls on industry (122:8).

These decisions led to placing all defense effort on an equal footing with civilian work. Mobilization work was not identified as urgent, so the Vietnam War was almost totally conducted as in a peacetime industrial operation. Businesses often refused to bid on defense contracts because those contracts were not as profitable as producing for civilian consumption. Further, the civilian production involved practically none of the red tape and bureaucracy of government contracts. Profits seemed to be the deciding factor even when the procurement people explained how urgently something was required in Vietnam. Therefore, defense production was slow and sometimes unsatisfactory in quantity, quality, or timeliness. Many horror stories could be told of this time in production. All of this led to competition between the Services for productive capability and competition between all Services and civilian production. This became very expensive, and seldom were we able to match production output with priority needs (36:69).

Government-owned facilities were not of great value until late in the war. As we earlier mentioned, these facilities had been left more or less alone with little spent on them for maintenance and upkeep over the years since the Korean War. They were generally in rundown condition, and the processes employed by their older equipment were old style. Millions of dollars had to be spent to make these facilities productive.

Particularly important were those facilities designed for the manufacture of munitions. Obviously, there is little or no civil market for military munitions, so these facilities produced only the munitions the military wanted. In peacetime, the needs were relatively small, and production was slow and in small quantities. When war needs arose, there was no time for buildup of production capacity. If the plants couldn't immediately produce, our forces were in trouble. That was the initial problem we faced. It was finally overcome but only with great expense and loss of very important time (39:70).

Early in the Vietnam buildup, it became apparent we were going to have to rely on contracted services for much of the support traditionally provided by military personnel. To meet this need, the Army established the US Army Procurement Agency, Vietnam. During the peak time, fiscal year 1968-1969, this agency awarded and administered contracts worth $500 million. The contracts covered supplies, subsistence, and services such as repair, utilities, power generation, distribution, stevedoring, transportation, data processing, maintenance, laundry, and other services. Table 10 shows the dollar value of these procurements (106:89).

The largest Army contract, measured in numbers of employees and dollar value, was for repair and utilities services. The buildup required a number of bases to be located at various points in the country. Each base consisted of a collection of permanent and semipermanent facilities for housing, messing, supply, storage, maintenance, and so forth—much the same as posts, camps, and stations anywhere else in the world. Each base required supporting base services just as they would elsewhere. The contractor furnished this support plus backup maintenance and supply to support that service mission (106:89).

The contractor furnished field maintenance and repair parts support for installed equipment such as power generators, air-conditioners, refrigerators, pumps, and the like. Additionally, the contractor-operated the supply yards for construction materiel. The lack of skilled labor in Vietnam resulted in the contractor hiring a great many American workers as well as a great many third country workers. To meet communications requirements, yet stay off the crowded military circuits, a separate radio network was established by and for the contractors.

	Supplies	Subsistence	Services
1967	$ 6.9	$12.0	$156.4
1968	11.2	13.6	234.3
1969	6.7	22.2	207.1
1970	6.9	19.8	210.8
1971	2.3	23.0	163.7

Note: All figures are millions of dollars.

Source: (106:89)

Table 10. US Contracts in Vietnam, In Country

The power generation requirements were quite large. Practically all areas were floodlighted at night for security purposes. The hot, humid climate required a lot of refrigeration and cooling to protect foodstuffs, medical supplies, and other weather-sensitive materiel. The communication and data-processing systems also required huge quantities of electrical power from dependable sources.

When a shortage of generating equipment was first noted in 1965, the Army and Navy jointly solved the problem. Some petroleum tankers from the US mothball fleet converted to power generating barges. They were sailed to Vietnam and anchored offshore. Their turboelectric generators were used to supply power ashore through hookup to a transmission station in the area distribution system. These temporary barges were later replaced with permanent generators ashore, but they saved the day when needed (106:89).

The Navy began contracting for construction soon after the buildup began. They tried to do enough but not too much. However, planning and projections for construction needs were poor because the strategy of *graduated military actions* provided very little base for forecasting accurately. It was very obvious the required work would be enormous. The objective was to have a number of construction projects underway simultaneously. The contractor (Raymond, Morrison-Knudsen) was told to gear up for a workload of about $5 million per month starting in January 1965. By May, the monthly rate was $12 million. In August, it was $15 million. The job became too big and two additional contractors were involved with the basic contractor. By January 1966, the construction rate was $40 million per month stabilized for a year. This was larger than Washington later approved, and a reduction was required. Before the cutback, the contractor construction personnel totaled 52,730 people (113:184).

One effect of this large construction contracting was the heavy flow of construction materiel arriving in Vietnam. This flood of materiel clearly added to port congestion. Further, many of these supplies were hard to handle, and that further complicated the problems in the ports. Delays and confusion were natural. Nevertheless, the contractors did a great job, and the procurement people earned all their salary and more.

Transportation

A war fought thousands of miles from the supply sources is almost totally dependent on transportation. Such was the case with the Vietnam War. At the beginning, the United States had a very small Merchant Marine fleet and only 89 old World War II ships in the Military Sea Transportation Service fleet. Through contracts with commercial shippers, charters with foreign lines, and activation from the National Defense Reserve Fleet, the MSTS ultimately acquired more than 500 bottoms from various sources, and these proved adequate for our needs. However, it must be mentioned there was no threat at sea to the movement of supplies from sources anywhere in the world to Vietnam. Had there been a naval threat, as in World War II, a different story would likely have to be told (122:9).

Vietnam was very much like the islands of the Pacific in World War II. There were no ports with deep-water piers. Tugs and barges, for the most part, did not exist. Amphibious craft were nonexistent. There was no harbor control with movement control facilities. Ashore, there were inadequate movement facilities and transportation to get the supplies off the dock. Until those conditions were corrected through massive construction and procurement, ships often had to wait in harbor for 2 or more months for offloading. Then, finally offloaded, supplies overflowed in the port shore facilities and could not be moved rapidly to point of storage or need. The absence of adequate road nets added to the dispersal problems, of course (122:10-11).

Sealift did achieve great productivity and effectiveness as the construction and buildup program began to produce results. The project called *Sea Express* used high-speed contract ships to expedite movement of the more critical bulk cargo to Vietnam. This not only obtained priority response to priority needs but also helped to meet the greatest part of the cargo movement needs for the war. Available data indicates that the sealift forces overall delivered 94 percent of all the cargo tonnage ultimately put ashore in Vietnam. The total delivered was approximately 17.2 million tons (106:77).

The success of US operations in Vietnam depended upon our capability to move a large military force to the area to sustain it in combat. The military forces were not authorized to requisition US commercial shipping. The need for ships, though, was great, as mentioned above. In early 1965, the cargo flow into Vietnam was 140,000 measurement tons per month. The last half of 1965 saw that climb to 460,000 tons and then to 740,000 tons by the end of 1966 (122:9).

With few exceptions, the ships of the Navy's Service Force used in Vietnam were of World War II vintage. Over the years since World War II, the service and support ships had gradually been whittled from the Navy's budgets in favor of combatant ships. This was understandable, but it created a significant problem when support was necessary. It was from World War II that we received much of the other naval resources as well. Floating drydocks, support vessels, small harbor tugs, and the like were of that source. Many of them had to be activated from reserve storage. Despite this, the Vietnam War saw a tremendous growth in Service Force capabilities for responsiveness and flexibility. The Service Force accomplished its logistics support mission with skill and effectiveness (113:24).

The Service Force used a great number of different types of vessel for its mission. There were repair ships and tenders for ship repair and technical supply. Ammunition ships, fleet oilers, fast combat support ships, provisions ships, stores issue ships, salvage ships, ocean tugs, survey ships, and replenishment ships were in this support fleet. The Pacific Fleet had wisely ensured continuing training for all crews in mobile support concepts and actions since World War II. Load lists of supply and replenishment ships were continually reviewed and updated to ensure the inventory contained the most likely needed items. When replenishment ships were in port, other ships were required to go to them for supplies before attempting to obtain needed supplies from shore installations. The purpose was to modernize and keep the inventory lists accurate.

Earlier, it was mentioned the Army developed the CONEX box in 1950. This box and alternate configurations of it proved exceptionally productive for the Vietnam war. The CONEX box, about a 7-foot cube, was made of steel and could be secured for shipment or storage. It fit in a standard military 2-1/2 ton truck or on semitrailer and rail flatbeds.

Army aviation units not only shipped their supplies in CONEX containers but also stored in them and worked from them. Their supplies were shipped in prebinned containers within the CONEX. On arrival, they could be set up to serve as unit technical supply with no further effort required.

At one point in 1966, the Army used CONEX boxes and container trailers to move an entire prepackaged depot of 53,000 line items, a 60-day supply to Cam Ranh Bay. The Marine Corps developed a variation of the CONEX as a mount-out box for deploying units. The Air Force used CONEX and palletized cargo concentration adaptable to its mechanized cargo-handling system (known as 463-L) for airlift (122:20-21).

While the CONEX boxes were intended for reuse in shipping, very few of them ever got back to the United States. It is estimated about 75 percent of the boxes, approximately 150,000, stayed in Vietnam and were used by the US forces and the RVN. They were used for supply purposes, as indicated above, for maintenance shops and even as offices at times. The RVN occasionally used them for unit jails and punishment boxes. They were extremely valuable for a variety of reasons (122:21).

The CONEX idea evolved into containerization and container ships, which greatly enhanced breakdown and offloading at the port of receipt. The containers, usually much larger than the CONEX box, were much like semitrailers without wheels. They would be packed with cargo of the same priority and carried to the shipping port by semitrailer or rail flatbed. At the port, they would be hoisted aboard ship directly from the dock and stowed either in the cargo hold or secured on deck. On arrival in Vietnam, the reverse could take place, and supplies could be immediately moved from the dock with the only delay caused by lack of roads or vehicles. A large portion of the ammunition shipments were moved via container ships with outstanding results, although not all such shipments were intelligently handled (122).

Before mid-1966, ammunition loads were often mishandled. At times, the ammunition was offloaded from pallets at the US exit port and loaded individually aboard ship to take fullest advantage of cargo hold space. This made for maximum use of the space but created great unloading difficulties on arrival in Vietnam. Ammunition should be stored with a lot of integrity for record and recovery purposes. But the way the ships were loaded, this was almost impossible because ammunition had to be taken from the ship in individual loads instead of in pallet loads. Records were thus confused, lots were mixed, and priorities were lost. The US loading action caused more than double the Vietnam offloading time and created horrendous stockage problems. In December 1965, there were

52 ammunition ships carrying 165,000 tons of munitions awaiting offload in Vietnam (106).

Airlift was a major means of transportation support for the Vietnam War. Almost all personnel movements, other than Navy ship personnel, to and from Vietnam were by air. The air transport was provided either by MATS aircraft or by charter flights from the US carriers. In addition, airlift served as the primary means of moving high-priority cargo when bulk and weight permitted. There were shortages of available aircraft, but the US military was not authorized to call up the Civil Reserve Air Fleet. Expansion had to be by contract and charter, which worked exceptionally well.

Again, as with sealift, it must be mentioned there was no enemy interference with airlift to and from the United States. Inside Vietnam and its adjoining countries, there was often attempted interference in the form of small arms fire, antiaircraft fire, harassment through communications, and occasional aircraft attacks (122:9).

At the end of 1965, in Project Blue Light, the 3d Brigade of the 25th Infantry Division, was airlifted from Hawaii to Pleiku for Vietnam duty. The Army wanted to move the 3,000 men and 4,600 tons of equipment and supplies in 30 days. MATS used 93 missions by C-141 aircraft, 122 missions by C-133 aircraft, and 26 missions by C-124 aircraft to do the job in 22 days. In this manner, the practicality of airlifting a full unit of combat troops and all combat gear for combat duty was reestablished. You may recall that in World War II a similar, though smaller, airlift into combat in New Guinea had been successfully accomplished (110:26).

Tactical airlift was used inside Vietnam to move people and supplies. These aircraft repositioned troops in and out of combat on a regular basis and moved tons of ammunition, food, and supplies often at great peril to the airlift crews and aircraft. In 1968, for example, they used C-130 aircraft to supply 6000 US Marines during the 3 month siege at Khe San. In 1972, for another example, at An Loc, theater airlift supported 20,000 RVN troops entirely by air during their time of encirclement. Airlift was proven effective in combat and out (110:26).

The Navy, too, had a form of tactical airlift. A few small aircraft, the largest was a C-47, carried passengers and cargo around Vietnam to meet navy needs. This *airline* usually kept one aircraft on alert for short-notice flights, but it also did its best to run a regular schedule. The flights were round-robin trips including, on the northern side, Qui Nhon, Cam Ranh Bay, and DaNang. Another round-robin included the southern bases of Vung Tau, Binh Thuy, An Thoi, and Roc Gia. This little operation made many vital contributions. Its ability to deliver personnel, parts, and other cargo made the support job of the Saigon navy possible (113:146).

But it did not come easy for any of the airlift services. Airfields had to be built because there were very few existing in Vietnam. Those airfields that did exist before the war usually couldn't handle the aircraft we were using. People had to be brought in to organize and operate airfield control and support facilities including passenger and cargo terminals, storage and distribution systems, personnel care systems including medical support, and a wide array of vehicular support. Even so, they managed to airlift more than 751,000 tons of cargo from the start-up in 1965 through 1969 (105:77).

Small aircraft were used for small package airlift in addition to their use as artillery spotting and air-land liaison. The helicopter achieved great success in its operations. It became the primary mover of wounded personnel from place of combat to place of initial medical care. Later, it evacuated casualties and other patients to full medical support facilities, including the Navy hospital ships. The success of this airlift is represented by the high survival rate of those wounded who were airlifted to field hospitals (162).

The Department of Defense established the *Red Ball Express* in December 1965 as a special supply and transportation system. It was designed to be used exclusively for expediting repair parts to return equipment to ready status. The Military Advisory Command had designated and reserved airlift for this purpose. The Red Ball Control Office was created in Saigon working with the Logistics Control Office, Pacific. Supporting Red Ball offices were established at each US supply source.

The Red Ball reports show that almost a million requisitions were processed through it during its lifetime. Of this total, 98 percent, representing 67,000 tons, were airlifted to Vietnam. The Red Ball concepts were integrated in Army directives in 1969, and the US depots gradually displaced the Red Ball function. It was effective for its mission and should be so noted.

Ground transportation was another story. Early in the war, there were few roads into combat areas or, for that matter, throughout the country. Most of the original vehicles brought into Vietnam from US-based units were used, high-mileage vehicles. They were generally unreliable, demanded a lot of maintenance, and were constant problems for operators and users.

There was no forecast that the war in Vietnam would last very long, so at first, only minimum vehicle maintenance facilities were established. Most were in the settled areas and did little good for those vehicles broken down outside the settled areas. Maintenance units and operator organizations, at first, were inadequately manned or often manned with low-quality personnel. It was found that some US units were using personnel requisitions for Vietnam as a means of purging their units of troublemakers and problems. It may be recalled that similar conditions existed when the REMCO was initially established in Japan for maintenance of Korean-based tactical aircraft. These conditions should be important lessons for logisticians for any future mobilization planning.

Spare parts for vehicles were hard to obtain. Shortages were very serious problems until senior transportation officials learned what was required and what was happening and corrected the problems. When that happened, transportation became more of the asset it proved to be as the war wore on (129, 258).

Vehicles belonging to the Navy were similar problems initially. The problems in that service, too, were soon corrected. The Navy vehicle fleet consisted of more than 1,900 vehicles,

including Jeeps, heavy trucks, buses, materiel-handling equipment, and construction machinery. In Saigon, alone, the traffic statistics reached almost 800,000 passenger miles per month and more than 55 million pounds of cargo per month (113:64).

The rail system in Vietnam was government owned. It ran the coastal area form Phan Thiet, in the southern end, to Dong Ha, on the northern end, all in the RVN. The overall condition of the roadbed and rolling stock was poor. The road suffered frequent interdiction and destruction by Vietcong and the North Vietnam army units. As a result, the system-carrying capacity was quite low even though it had been very well engineered and originally constructed. It had its own, generally satisfactory, maintenance capability with shops at major stations on the route.

In coordination with the RVN, and the Ministry of Communications and Transportation, the United States provided considerable rebuild, reconstruction, and repair to the road. Further, spurs were constructed into major US bases for cargo delivery. Approximately $17 million of US aid went into this railroad restoration and extension effort. The rail system was of considerable value to US forces. It hauled hundreds of thousands of tons of rock and gravel; for example, for US construction programs on our bases and installations, roads and ports, and so forth (106:165-6).

Communication and Data Processing

The lack of adequate communication networks in Vietnam was mentioned as one of the difficulties facing the logistics system as the United States began its buildup. There was only a minimal telephone system, which was without service. A primitive radio network existed, but it was outmoded and of little promise for support. Very minimal telegraphic capability was present. All of these communication means were decidedly unreliable, and all were definitely unsecure. They could be used only with good luck and only when it was not absolutely essential the message be received and understood. As the United States moved advisors into the country, some additional capabilities were created, but they were almost totally in the wireless category.

As our involvement grew so did the need for more and better communication capability. Concurrently and very importantly, there was need for coordination. Most of the equipment our combat advisors used was portable radio of low power and sometimes low quality because of weather and environmental conditions. The advisors worked to improve the communication conditions and equipment, but as they did, the involvement of US forces grew. With that came the need for more logistics data. Requisitions for supplies and combat materiel began to increase greatly. Required reports increased in number and scope. All were of great importance to the support people in country and of even greater importance to those in the United States who had to satisfy new needs and new quantities of materiel. All of this influenced a growing clamor for automatic data-processing equipment with greater capacity and capability than the punchcard equipment available in limited quantities through the RVN armed forces.

Army communications evolved from a single half-duplex radio teletype circuit available from 1951 between Saigon and Clark Air Base in the Philippines. By 1969, the system had grown to 220 installations with almost 14,000 circuits. This extensive network was equipped with new standard tactical equipment, automatic message switching centers, and telephone exchanges. All of this required logistics support, and it was provided by the more than 19,000 men of the 1st Signal Brigade located throughout the RVN (106).

The general communications condition may be described as totally inadequate in 1965 changing to acceptable by 1968 and after. In the early time, a great many requisitions were *lost* in the communications mess. Units suffered because of this. The demand for improved communications capability finally obtained the needed support, resulting in dial telephone exchanges, secure voice networks and data transmission facilities at every major installation.

The US military forces had accepted and applied current technology for information processing in the United States. The computer had become a major and almost indispensable element for much of logistics support planning and management. However, the use of the computer to move data from installation to installation or from Vietnam to Okinawa, Japan, or the United States demanded high-quality transmission systems. These were not available to the US forces in the early years of the buildup. Supply support, for example, suffered. Requisitions had to be handwritten or typed and either mailed or sent by radio to support units. Many were lost or garbled, causing unsatisfactory support. Further, personnel trained on a computer-based supply system at home had difficulty accommodating to the conditions with no computer.

Computers were rapidly introduced to Vietnam. There were many problems with climate and environment and with poor quality, unreliable power systems. As the use of the central computer increased so, too, did the use of small, sometimes portable, units. This further increased the need for fast, high-quality transmission capability to move the data. Service and maintenance for the computers and their data networks were frequently provided almost totally through contract support.

There were continuing problems throughout the time the United States was militarily active in Vietnam. The available circuits, even those we created, were often inadequate and of relatively poor quality. Much of this was caused by weather and humidity affecting the equipment. Some of it was caused by our use of communications gear, which was not permanently installed but was rather makeshift in its siting and protection. Some of the problems were caused by the shortage of skilled people to operate and maintain the equipment and systems. Many of the personnel problems were solved through contract support from US manufacturers and service companies. Contractor service personnel sometimes served for several years in country doing their jobs in excellent manner.

By late 1968, secure and acceptable quality data nets had been installed. AUTODIN (automatic digital network) was installed for digital transmission of data and enhanced the conversion from teletype to computer message origination.

AUTOVON (automatic voice switching network) was the voice network established within country and for oral communications with US forces and installations worldwide. Even after these were established, many problems remained because we were never able to eliminate weather and environmental degradation factors.

The Air Force solved some of its problems by adopting the Univac 1050-II base supply system in the United States as well as at 15 sites in Southeast Asia. These systems were compatible. Data generated in Vietnam could be used in Vietnam or in the United States. Similar adaptations were made by the other Services although not to this extent (259).

The Air Force also established a worldwide study of the automation of logistics systems at base level in September 1968. This was known by the acronym STALOG, and it included the standard base supply system, maintenance management information and control system, transportation integrated management system, and customer-integrated automated procurement system (261). STALOG ultimately netted a standardization of system data elements that helped to make data-processing and cross-system data use feasible and practical. However, STALOG never attained all it was hoped to attain.

At the same time, the Air Force Logistics Command was extensively studying and developing the Advanced Logistics System (ALS). It was intended to tie together the great quantity of separate systems and often separate data elements that the command had developed and accumulated over the years. This mix of often incompatible data elements and systems was difficult for the command and for the Air Force. Further, it made cross-service data exchange almost impossible. These conditions were aggravating to the command and impacted its effectiveness of support to Vietnam. ALS helped identify and solve some of the command system problems but was only partially successful. Its lack of success was due to a number of causes, which must be reviewed at another opportunity. The study finally ended with ALS being neither completed nor adopted.

Supply

Supply operations were affected early in our involvement in Vietnam by:

- The lack of adequately qualified people.
- The absence of adequate facilities.
- The lack of simple supply control.
- The weather and exceptionally high humidity.
- Theft, often on a grand scale.
- The lack of adequate computer support.

Supply support for the US Army and Air Force involvement in Vietnam began with a *push* supply system similar to that of World War II and Korea. It netted pretty much the same results: inadequate support of critical items, far too much of the unnecessary, and no means for becoming more sensitive and responsive to combat and support needs. It was not satisfactory. The decisions from far away about what was needed and when were just not suitable to actual field conditions.

Ultimately, supply support changed to become basically a pull system as adequate communications became available. Still, even with improved communications, supplies were wasted. Units generally ordered far more than they required and very often ordered materiel and items that could only, in retrospect, be called unnecessary luxuries. Many of the fixed-base offices soon came to resemble well-equipped offices back in the United States, for example (122). As time passed, the supply systems became more effective, and in the early 1970s, high-priority items were obtained in country in 6 days or less from requisition to receipt.

There had been some preliminary planning by the staff of the Commander in Chief, Pacific, for supply support, but it had little operational relationship to need. Planning for common supply support among the Services was not well done at first. This caused great anguish and expense through improper support materiel and processes. The Army and the Navy shared most responsibilities for common support. The Air Force was not given common support responsibilities because, theoretically, it had no meaningful joint service supply background. The Air Force did, though, voluntarily become a joint-service supplier by assuming supply assistance for nearby units without regard to whether they were Air Force, Army, Navy, or Marine Corps units. With cooperation, things worked effectively, and by all accounts, logistics supply support overall was acceptably effective (122:16).

All Services report they experienced difficulties obtaining common supply support in Vietnam. The Navy, for example, indicated that the common support from the Army was unsatisfactory at first. Discussions with responsible personnel resulted in agreement to use *fill or kill* on common support. The Navy would first attempt to draw from the Army the common supplies it needed. If the Army couldn't satisfy the need, it would *kill* the requisition, and the Navy would then requisition from Navy sources in Japan, the Philippines, or the United States (113:142).

The Army had a similar complaint and so did the Air Force. General Joseph Heiser stated, "The situation facing the Army, Navy and Air Force logisticians in Vietnam during the early days of the buildup was such that no one Service was particularly anxious to support another" (106:82). Common support included such items as subsistence supplies, clothing, and general supplies primarily for housekeeping, maintenance, and administration. The Army and Air Force also went to the *fill or kill* process, and soon all three Services were on common ground.

However, the supply systems were bothered early by the inadequacy of control processes operated by improperly trained personnel. There was no agreed upon listing of common supplies to be furnished by the designated supplying service. Further, much materiel could not be found because the paperwork couldn't be located to show what was located where and how it might be identified. Even though this was considerably cleaned up over time, the problem continued to some extent for the entire time in Vietnam.

The depot operations in 1968 possessed about 2 million tons of materiel, but only about one-third were available for issue. The majority was *lost* and not on existing, usable supply records (105:75). Millions of dollars worth of supplies were doubtless wasted in this manner, because very often, when they were finally located, the weather and environment had gotten to them, and they were no longer usable. When the system was cleaned up, supply discipline improved, and waste was reduced. In late 1968, showing signs of beginning supply logic, almost $400 million worth of supply requisitions were cancelled before the supplies left the United States because they were found to be unneeded in Vietnam (122:10).

Morale supplies became a major load on the logistics system. In 1967, US forces were using 9 pounds of base exchange type supplies per man per day. Recognizing the different culture and impetus, we still should consider the following:

> The Vietcong required for its armed force operation from 15 to 100 tons of military supplies per day, plus foodstuffs. The VC forces lived on very little food. At this same time, UJS forces were consuming 1,500 tons of base exchange supplies, alone, per day. One senior military official has told me that at the height of the Vietnam conflict, the United States had approximately 256 ships in the pipeline at all times delivering supplies. Eight of these ships, in equivalent loads, would always be filled with beer and soft drinks for our forces in Vietnam (106).
>
> This form of logistics support is likely not sustainable under heavy wartime requirements. Our logistics system and our senior military leaders should certainly condition the troops to expect far less of these luxuries and more of the harsher conditions. War should never be made easy for the combatants. War and combat should be conducted to win the battles and cause the enemy to bow to our will. It is difficult to see how this heavy expense of *luxury* supplies can contribute to that end.

The repair of recoverable components was a constant problem affecting maintenance, supply, and transportation. In the Air Force, the policy was maximum base self-sufficiency. Under this policy, each base was expected to do all repair possible and forward to the depot only that which was beyond their capability. Many maintenance units in country were not very capable because of the lack of shop facilities and the heavy workloads for assigned technicians. As a result, reparable items collected at supply points and were held there. Obviously, these were of little help to anyone, but they represented millions of dollars in unusable vital assets. Similar situations existed in the other Services. Strong efforts were required to ensure prompt shipment back to repair facilities in country, contractors in the Pacific basin, or facilities in the United States (122, 259).

The Air Force used the war readiness spares kit (WRSK) for early support until routine supply activities were established. The WRSK had 2,500 line items and was designed to support 30 days of operations for a small flying unit. The kits were effective, and the Air Force learned a lot about what was and what was not required in combat support when it analyzed the issue records.

Also, the Air Force used *Gray Eagle* packages, which were sets of materiel and supplies for housekeeping and operations, to support 4,400 people. These, though, were a great drain on available airlift and were finally eliminated from the Vietnam supply support in favor of dependence on supply activities in country.

The Navy used underway replenishment for a great deal of its support of the ships and vessels. Underway replenishment ships contacted the other ships of the fleet on a regular basis and, while steaming, transferred supplies to the other vessel. Some of this was done via pipeline for petroleum products, crane lift for bulk supplies, and by helicopter. Table 11 shows the underway replenishment of Vietnam compared to similar activity in World War II and shows the increased supply usage in the Vietnam War (113:47).

The replenishment effort for ships at sea required long and arduous work by the crews of the replenishment ships. They had little in-port time to call their own. When in port, they were in almost constant effort reloading for early sailing. When at sea, they were continuously working the cargo in preparation for replenishment or in moving the cargo to the other ship. It was far from a glamorous duty, but the crew morale seemed to get higher the harder they worked and the more they were expected to do (113:57).

The Navy and the Army both used the helicopter to great advantage for supply. The Navy often referred to this as vertical replenishment. The Army merely called it aerial resupply. Either way, a great number of tons of vital supplies moved by air using the helicopters or fixed-wing aircraft as necessary. We earlier referred to the aerial support of marines and RVN troops under siege. There were very many similar, but not so dramatic, aerial support operations carried out. In some instances, the helicopter resupply was the difference between life and death. In other cases, the aerial resupply provided strength for victory rather than defeat and retreat.

	Vietnam	**World War II**
Ammunition	15,000 tons	7,000 tons
Aviation Gas	450,000 bbls	221,000 bbls
Provisions	2,699 tons	2,800 tons
Mail	3,400,000 lbs	1,005,000 lbs

Note: This data compares 1 month of underway replenishment during the Vietnam War with 1 month in World War II at the peak of the Okinawa campaign. The number of ships involved in Vietnam was a great deal smaller than in the World War II campaign. Supply requirements had obviously grown dramatically in short time.

Source: (113:47)

Table 11. Underway Replenishment Comparison

Munitions

Munitions are a peculiar military requirements. There is no sizable and reliable civilian market for most of the munitions required for military weapons. Therefore, the Department of Defense must either subsidize the munitions industry to keep it operating or somehow provide sufficient continuing orders to keep munitions production profitable or construct and operate its own munitions production plants. Neither is fully satisfactory. The United States has chosen to attempt to do all three more or less simultaneously.

A further problem, of course, is the fact that in peacetime operations the military forces really cannot afford to expend large quantities of munitions. And it takes large quantity usage to make the production runs needed for profitable operation. So we have often used government-owned arsenals and munitions plants to produce, store, modify, and maintain certain munitions during times of peacetime. We buy other munitions from civilian producers in limited quantities during peacetime but seldom enough to retain a healthy, responsive munitions industry.

Therefore, when war erupts or a national emergency demands mobilization, we find ourselves quickly short of munitions with no industrial base to call upon for rapid action. Such was the case for the Vietnam War. Our experience in that war clearly shows that munitions logistics requires constant command attention and specialized management. The management must come from munitions experts closely coupled with strategic and tactical planning. Strong efforts are required to keep the munitions industry and the munitions logistics systems in readiness for immediate response to emergency and contingency requirements (124:2-4).

As we have mentioned, the Vietnam buildup by the United States found the munitions industrial facilities unable to produce safely or adequately for our needs. Over the years, the government-owned facilities had not been properly maintained. For somewhat understandable reasons, when budget reductions were necessary, the dollars flowed to the events and needs more visible and more *important* than currently unused munitions and munitions production facilities. While we never had extremely dangerous long-term munitions shortages in Vietnam, we did experience shortages, some severe, throughout the war (122).

Munitions procurement was vested almost wholly in the Army and Navy according to tradition and precedent. The Air Force had little or no munitions procurement responsibilities. There was considerable confusion because of indefinite responsibility assignments and incomplete coordination. When it was accomplished, the use of single service project management for specific munitions was found to be feasible and effective. We should note that and practice it more in the reality of everyday functioning in the Department of Defense.

Also, munitions procurement and production assignments should be consistent with service use and technical capabilities. That was not necessarily the case for Vietnam. In illustration, the Army was responsible for the loading, assembly, and packaging of conventional bombs even though the Army did not use those munitions. The Air Force and the Navy did use them in great quantities. But, the Air Force, the largest user of bombs, had no munitions procurement responsibilities for them. The Army was also responsible for incendiary and napalm bombs, again with no usage by that service. The selection of project management for munitions should have been more carefully tailored (122:8, 35).

Normal peacetime industrial production of munitions doesn't meet combat needs, as we have stated. Ordinarily, during a war, the government would order munitions for combat under some form of priority control for resources required and for work being performed. However, for the Vietnam War, the United States did not exercise industrial mobilization. The decision was to let military production needs compete with civilian production requirements without imposition of controls or priorities. Therefore, munitions production did not get the priority it needed, and shortages of munitions became a major problem at times and a worrisome problem always (122).

Munitions production quality was a problem, and it took a long time and a lot of effort to correct. It is life-threatening in combat when ammunition will not fire or will not fit the weapon in use. When mortar shells explode prematurely, friendly forces suffer rather than the enemy, and the mission is endangered. Bomb duds are an expensive waste of effort, and they expose flight crews to mortal danger for little tactical value. It is clearly necessary for munitions production to provide quality at all times.

Additional problems were created by the mixed emotions of American citizens about US involvement in Vietnam. The nightly television news brought the war directly to the homes of Americans, and for many, this became their first awareness of the actual horrors of combat. The use of napalm and other incendiary munitions was a particular bother and aroused many strong emotions. Aroused citizens, including many student groups, picketed napalm plants and interfered with production and shipments. Human body barricades prevented trucks from moving. Trains were stopped in the same fashion. Yet, in Vietnam, napalm was an effective weapon, sometimes the only practical weapon, against the entrenched enemy forces and those in the mazes of tunnels under Vietnam. Without napalm and other incendiaries, more US lives were likely to be lost. But at home, the families were often demonstrating against its production and use. It was a no-win situation for the combat troops.

During the buildup, the munitions situation was chaotic. There were only small quantities of various munitions available to begin with, but soon, the packages being pushed to Vietnam began to arrive. They arrived before the units for whom they were intended. Sometimes, the units, on arrival, were diverted to an offload site perhaps many miles from the offload location of their munitions. Munitions piled up on the beaches and aboard leased sampans in the harbors. Gradually, the problems were resolved to at least be controllable if not completely solved. The push supply system for munitions became a pull system with greater efficiency (106:107).

FY	Total	Vietnam
1965	338	305
1966	1,313	853
1967	1,329	1,007
1968	2,328	2,206
1969	2,913	2,719
1970	1,731	1,456

Note: Figures in millions of dollars.

Source: (105:119)

Table 12. Army Munitions Programs

Expenditure rates for munitions exceeded all forecasts and far exceeded historic data. Table 11 reflects this to some degree for the Navy. Table 12 shows the growth of munitions usage in Vietnam in dollar values. In some instances, units expended in 1 or 2 months more than their predecessors had expended in the whole of World War II. (113:46) (106).

The quantity of munitions moved for the Army to Vietnam in 1966 averaged slightly under 40,000 short tones per month in 1966, 75,000 short tons per month in 1967, and about 90,000 short tons per month in 1968. In addition, the Army had to offload Air Force munitions, averaging more than 25,000 short tons per month. The lack of adequate ports and facilities for handling munitions made this even more difficult. Very often, the munitions had to be offloaded from the munitions ships to barges and lighters then again offloaded at the beach for loading and movement by trucks.

It took considerable inconvenience and loss of combat capability in Vietnam to alter the initial shipment and offloading of ammuniton. The lesson of that experience should not go unknown to logistics people and particularly to those involved in logistics combat planning. The lessons of Vietnam logistics as related by General Joseph Heiser should be studied by every budding logistician of all the Services (106).

Prior to mid-1966, the discharging of ammunition ships was constrained by the fact ammunition was unloaded from pallets at CONUS ports and loaded aboard ship by individual boxes and projectiles. This effort made for maximum use of ship bottoms but created great difficulties in Vietnam where this mixup required offloading by cargo nets and hooks while attempting to maintain ammunition lot integrity in the in-country depots. The management of ammunition dictates that it can be stored and accounted for by lot number. Action by the Vietnam logistics commanders got this changed to revert to palletized shipments. This permitted lot integrity to be maintained in the ship's holds to the greatest practical extent. Offload efficiency was improved by reducing offload time from 7 to 4 days, a significant improvement. Prior to this, in December 1965, for example, there were 52 ammunition ships with an estimated 165,000 short tons aboard on hold in port awaiting offloading. This really hurt the effort to build up an in-country stock level while simultaneously supporting the growing combat requirements.

Some ammunition materials were in short supply. This required the ship's manifests be reviewed, and sometimes a ship had to be moved in ahead of others for selective partial offloading before going back out to its cargo-holding lineup position. The crowing sometimes required shipments to be moved to other ports even if that meant less efficient offloading and storing. In addition to the problems with in-country combat ammunition support, the inefficiencies added to the costs of shipping by greatly increasing the demurrage and other costs of the idle shipping awaiting offload. Thus the relative shortage of shipping was made worse by this relatively poor usage of available bottoms. Ships are meant to sail, not sit at anchor awaiting cargo handling.

The lesson should be obvious. No matter how much we might desire efficient use of the transportation medium, the driving factor in deciding how to load and offload should be ultimate support end requirements. Therefore, logistics planning must consider how the supported end of the line will handle and use the supplies before deciding how to load or package (106).

Three major ports existed in Vietnam for munitions offloading: DaNang, Cam Ranh Bay, and Saigon. Two other ports played a role in munitions supply: Qui Nhon and Vung Tau. At Qui Nhon, though, the offload problem was amplified. Ammunitions ships had to be offloaded offshore because sand bars prevented oceangoing ships from entering the river mouth. When the weather was bad or the seas heavy, the ammunition ships had to move farther out to sea for safety, and offloading had to wait. The same condition existed at DaNang until a breakwater was erected in 1968. All in all, before Army and Navy port construction efforts, the Vietnam port situation was very poor and inefficient for all the elements of military logistics support (106:106-128).

During the buildup, the expenditure of ammunition created shortages, and back in the United States, large requirements for procurement of munitions. To ensure that such procurements were done with competition and to try to control the large dollar effect on the economy, Secretary of Defense Robert McNamara established guidance for procurement. Certain approvals were required when the contract was for Vietnam support and the basis of procurement was changed from competitive to noncompetitive. The Service Secretary had to approve *before the fact* contract awards of more than $1 million. Assistant Secretary of Defense (Installations and Logistics) approval was required for contracts exceeding $10 million. If the exigency was such that extraordinary procurement actions were used to ensure production continuity, after- the-fact review and notation were required. After 1969, these controls were removed but with insistence for continued maximum emphasis on competitive procurement (106:120).

One other problem warrants mention at this time. There was no adequate training for munitions people. Most munitions manpower requirements were filled with civilian employees of the Services or their contractors. Not many

military personnel worked in or were competent in munitions, and there was no training program that could be rapidly enlarged and speeded-up to meet the needs in Vietnam. Yet the munitions expenditures grew, and the need for competent people grew as well. It was finally met by the extraordinary effort of a lot of people in the Army, Navy, Marine Corps, and Air Force who worked minor miracles to train and qualify military personnel destined for Vietnam duty.

Petroleum Products

The Vietnam War was an extension of the notion of mechanized mass of World War II and Korea. The use of mechanical advantage equipment grew in this war, and as a result, petroleum supplies became very important. There were massive requirements for petroleum products, and on the whole, the Department of Defense met these needs very successfully. To do so, though, required a lot of construction to create port facilities for tankers, storage tank farms, pipelines, tanker truck organizations and networks, and all the other facilities needed for POL distribution. Additionally, tight security was needed because petroleum storage was a prime Vietcong sabotage target. There were problems with contract administration for petroleum procurement involving duplicate billing, inadequate controls on paper processing, and the *lost* inventory of the other supply systems (122:17). Nevertheless, the supply of petroleum products was never a restricting factor in Vietnam, and the overall job of petroleum supply must be classed as superior.

As in World War I, the need existed for a great number of petroleum products in a great number of different sized containers. Gasoline, both aviation and ground, was required in huge quantities, mostly in bulk. However, the fuels were also needed in barrels and smaller 5-gallon containers as well. Diesel fuel was needed in this range of storage. Kerosene was required mostly in barrels and 5-gallon cans. Other products had their own distinctive packaging requirements. This wide variety and range of packaging made inventory control problems and storage problems in addition to the problems of handling, offloading, and moving.

The Army and Navy were jointly responsible for supplying petroleum to forces in Vietnam. Each service had assigned supply areas. They jointly constructed fixed petroleum storage facilities ultimately holding more than 1.6 million barrels. This would be more than 72 million gallons. Most of these facilities were at port locations, but some had to be constructed inland to handle requirements and meet demands. The Air Force, additionally, had more than 350,000 barrels of storage at various airfields. Civilian contractors and petroleum companies had another 1 million barrels of storage, mostly in the Saigon area. That was all helpful, but the storage was not at the intended point of consumption so other means of distribution had to be used. These were on pipelines, fuel trucks, bladders and the like. In addition, at sea, the underway replenishment of aircraft fuel to aircraft carriers far exceeded even the records of World War II (122).

Year	Barrels
1964	2,700,000
1965	6,875,000
1966	21,850,000
1967	36,280,000
1968	48,650,000
1969	41,785,000
1970	36,450,000

Source: (106)

Table 13. Petroleum Consumption—US Army, Vietnam

Petroleum storage was always a problem, but at first, it was far worse than expected. The contractors in the area were influenced by US policy statements indicating the war would be short-lived. They did not want to put large sums of money into extensive storage facilities that would in short time be excess to the needs of the area. So we had to use all forms of temporary expedients to meet early needs while we worked hurriedly to create semipermanent storage. This included the use of bladders, floating storage and other short-term storage and transshipment through Japan and other sites. The result was that petroleum supply in Vietnam was probably much more expensive than it might have been had decisions been made early for sound permanent storage (122).

Even with all the storage that finally provided, the in-country petroleum supplies seldom exceeded 20 days supply. Table 13 reflects just the Army consumption in Vietnam from 1964 through 1970 but should provide the reader with a good idea of the size of this logistics effort. Consumption was high throughout our involvement in Vietnam. There is no question of that. However, we must consider a number of factors causing that consumption:

- The use of high-performance Air Force and Navy aircraft.
- The use of B-52 aircraft for conventional bombing.
- The extensive use of fixed-wing and helicopter aircraft for logistics purposes, including medical evacuation.
- Extensive use of many forms of powered equipment such as river craft, harbor craft, construction gear and so on.
- Naval ships of the Pacific Fleet.
- Huge inventories of road vehicles for personnel and logistics movements.
- Enemy-induced losses.
- Leakage and evaporation.
- Theft.
- Climate-induced fungi and other impurities (106, 122)

The Pacific is quite large, and the fleet ranged the whole ocean. Even concentrating on the Vietnam coverage, a fleet oiler usually sailed about 3,500 miles between load-up in the Philippines and return for a new load. The massiveness of this underway replenishment might be shown by recounting one 8-month deployment of the *USS Ponchatoula*. She conducted

484 replenishments to 503 ships transferring 50 million gallons of fuel and 69 tons of other freight cargo. On one day, she conducted 20 replenishments and 1 consolidation with another oiler, transferring more than 2.5 million gallons of fuel oil and 630,000 gallons of jet fuel (113:51-2).

For the air and ground war conducted within Vietnam, we depended greatly on commercially shipped petroleum. The three in-country commercial distributors provided much of our supply and distribution. This is reflected in Table 14 (106:76).

Distribution in country was a continuing problem. There was always an inadequate quantity of tank trucks available. The trucks frequently had mechanical problems. Maintenance was effective but slow and couldn't solve the problem. So the Army installed pipelines wherever they were needed and could be protected. The lines were constructed of 20-foot lengths of steel pipe joined with bolted couplings. These worked well but, of course, were subject to occasional damage from Vietcong or North Vietnam troops and the pilferage by local Vietnamese.

Large quantities of 55-gallon drums and 500-gallon collapsible bags of all types of petroleum products were airlifted to upcountry terminal locations. The Army would package these products, and the Air Force would deliver them to the site needing the petroleum. In the 3-month siege of Khe Sanh, for example, the Marines were provided airdropped fuel, along with other essential supplies, in this manner. The Air Force operated the *bladder birds,* flying as much as a million gallons of fuel a month to isolated or cutoff areas (106:79).

Pilferage was always a problem. The easy availability of fuel was a real temptation to the improvised Vietnamese. They often took advantage of insecure storage or distribution to obtain some gallonage. General Heiser estimates we lost more than 250 million gallons of petroleum to pilferage—more than $36 million. The local drivers of tanker trucks would sometimes install false bottoms for their personal share of the load or they would tamper with seals, forge documents, or take other actions to illegally obtain fuel to sell. The pipelines could be easily unbolted with readily available wrenches. As the fuel leaked from the loosened joints, it would be collected in cans or buckets and carried away. It took a lot of manpower and time trying to solve these problems (106:81).

Year	Commercial	Military Sea Trans Service
1965	100	0
1966	87	13
1967	61	39
1968	57	43
1969	69	31
1970	43	57

(Reflected in Percentage)

Source: (106:76)

Table 14. Fuel Distributed by Prime Carriers

However, even with all the problems related to petroleum transport and distribution, it was generally agreed by the tactical commanders of Army, Navy, Marine Corps, and Air Force units that the petroleum logistics support was gratifyingly adequate.

Maintenance

When we initially entered the Vietnam War, the decision in the Department of Defense was to rotate flying units into the country for short temporary duty periods. Therefore, there were no provisions—or planning—for made for extensive maintenance support in country. Instead, heavier nonorganizational support maintenance for Air Force and Navy aviation elements was done in the Philippines or Japan. This was effective but costly since it involved the shuttle of aircraft to and from the maintenance facility hundreds of miles from the combat arena. In most instances, the maintenance of the aircraft in country was at first minimal. Much of the action to adapt maintenance to combat was in the form of extending the time between required inspections and directed maintenance. This was helpful but did not solve the real problems of aircraft maintenance.

Air Force maintenance policy called for base self-sufficiency. This required each unit to do all the maintenance it could and move to the next higher echelon only that which exceeded its capability. To do this meant maintenance had to have facilities and equipment because much of the needed maintenance could not be accomplished on the aircraft or in the open air. Further, base self-sufficiency demanded a continuing supply of bits and pieces, spares, and other supplies. The maintenance support in the Philippines did not, of course, permit self-sufficiency in Vietnam, so a new and major problem for supply support was created.

As time went by, the policies changed and so did the maintenance facilities and organizations. Some units became so permanently assigned to their base of operation they could and did create shop and other maintenance facilities almost identical to those in the United States. As this took place, the Air Force maintenance support for Vietnam in the Philippines phased out for the most part. TAC fighter organizations coming into Vietnam were organized in a variation from Air Force Manual 66-1 and had more maintenance responsibility in the flying squadrons. This structure, known as the TAC Enhancement Plan, was adopted for Vietnam finally and became the guiding policy for operational maintenance effort.

Meanwhile, the Strategic Air Command was operating its B-52 and KC-135 forces out of Thailand and Guam. The effort in both locations was very large, and the maintenance forces were almost equally sized. Generally, the SAC maintenance organization followed the specialized maintenance concepts developed by the command and reflected in AFM 66-1. Some variations were made to accommodate to local conditions and missions, but SAC proved to its own satisfaction that its maintenance ideas worked under its combat conditions. On Guam, the aircraft of several wings were merged into one operational fleet, and maintenance was a large and complex affair.

In the early days of involvement, maintenance mobile vans were employed for mobility and shelter. These were variously sized enclosed vans on semitrailers or flatbeds that could be moved to a site and quickly set up for operation. Additionally, they were air mobile via C-124 and could be rapidly moved from the United States to Vietnam. They usually had their own power generators and a basic supply of essential materiel. The vans, very similar to those used by service squadrons in World War II, were especially equipped for machine shop, sheet metal shop, instrument shop, and other shop needs (6:110-112). They were effective for their time but were generally eliminated as facilities were constructed and the need for them lessened.

Recognizing the need for onsite depot level support in Vietnam, the Air Force Logistics Command developed Rapid Area Maintenance teams. Similarly, Rapid Area Supply Support teams were also established. Both were manned mainly by civil service employees of the command and were sent on temporary duty to Vietnam. They took with them the tools and equipment they would need and stayed in country for varying periods ranging from a few weeks to months. They were effective and of great value assisting US forces and, additionally, training RVN personnel (235).

The maintenance concept in support of the Navy's forces in Vietnam was influenced by several factors. These included the changing operational requirements, the scarcity of suitable real estate, insufficient dredging services, time-consuming land reclamation, cutbacks, and reprogramming of the military construction program, and the steadily increasing tempo of operations. Construction of facilities for maintenance and repair of vessels ashore was dependent on the availability of real estate, including any that could be obtained by dredging fill (113:142).

Stopgap measures were taken initially. Covered lighters were provided with cranes and machines shop equipment taken from supplies intended for advanced shore bases. These modified craft supported Nha Be and Can Tho. The high readiness attained was a tribute to the combined ingenuity and hard work of the maintenance personnel in the boats and on the bases. By 1966, more than 6,000 personnel were thus employed in shore or near shore maintenance facilities (113:142-3).

Navy aircraft maintenance was predominantly done on the carriers using the same processes and procedures they had used for some time. No particular accommodation was deemed necessary or made for the Vietnam maintenance support. The maintenance was exceptionally effective and readiness rates very high. Turnaround time was low, and the rate of turnaround was exceptional. Aircraft units ashore accomplished maintenance in much the same manner with equivalent results.

Army ammunition maintenance was a significant problem. Usually, maintenance of ammunition in combat was routine and done by trained military renovators. But in the Vietnam War, the munitions facilities had been largely civilianized thus eliminating training for many military personnel. The climate and environment of Vietnam created a munitions degradation problem requiring great effort to handle. Renovation personnel were provided each ammunition battalion, but these people were pretty much limited to preservation and repackaging. Boxes and crates deteriorated rapidly in the Vietnam environment and had to be continually reserviced or replaced.

The disposal of condemned munitions has always been a problem in combat areas. Highly skilled explosive ordnance disposal personnel were trained by each of the Services for this need. They worked under a form of central control to provide support in:

- Destroying deteriorated munitions.
- Destroying enemy damaged munitions in storage.
- Clearing boobytraps.
- Assisting in recovery of gunships and other aircraft.
- Rendering safe any munitions on those aircraft.
- Clearing mined areas and facilities.
- Disposing of enemy caches of explosives.
- Rendering US facilities unusable before we abandoned them.
- Clearing dud munitions and destroying them.
- Clearing and destroying time-delay munitions that had not exploded.
- Training combat troops on boobytraps and mines and how to handle them.

Army aircraft increased from very few in the hands of advisors to more than 4,000 in more than 142 company-sized units late in 1969. Aircraft maintenance personnel and activities increased accordingly. Qualitative personnel problems in supply and maintenance were particularly critical for the Army because of the nature of the aviation materiel maintained (106:139). Civilian contractors were used to augment the military capability in critical areas such as sheet metal and structural repairs. Table 15 shows the number of in-country aviation maintenance contract personnel employed by year. Additional capability came from Department of the Army civil service employees and from manufacturer's field service engineers.

As with the Navy and the Air Force, maintenance facilities for aircraft maintenance were of special importance to the Army. Facilities in all Services for the maintenance of aviation

Fiscal Year	Lockheed	Lear Siegler	Dynalectron	Total
1965	—	—	34	34
1966	—	—	239	239
1967	—	457	550	1,007
1968	100	624	847	157
1969	232	832	1,056	2,120
1970	287	733	872	892

Source: (106:139)

Table 15. Contract Maintenance Manning Level, Vietnam In-Country—US Army Support

and data-processing equipment were necessary because of the sensitivity of aircraft and computer components to the environment. Maintenance tents were of little value because they disintegrated rapidly in the Vietnam climate. Also, tents could do little to protect sensitive parts from humidity, vermin, or dust. The tents were too small for housing aircraft and much of the work required. The few mobile shop vans, similar to those described earlier for the Air Force, were too small for sheet metal repairs on cowling and too small for rotor blade balancing. Permanent or semipermanent, specially designed facilities were necessary and ultimately provided.

In April 1966, the Army deployed a floating aircraft maintenance facility to Vietnam. This was the *USNS Corpus Christi*, which was a converted seaplane tender. It was designed for use in contingency operations initially for immediate direct support supply and maintenance. It was equipped to provide a limited depot capability for repair of aircraft components; manufacture of small machine parts; and repair of avionics, instrument, carburetor, fuel control, and hydraulic components in a clean, almost sterile environment. It was, of course, mobile and could move from one anchorage to another as support need demanded. It successfully assisted in the return of many aircraft to combat availability (106:146).

The overseas pipeline for aircraft engines in the Army was initially established at 13 months. This covered 8 months in supply levels at US depots plus 5 months for transit time and overseas stockage. One month of pipeline was considered to be equivalent to the number of unserviceable aircraft engines generated in 30 days. Thus, at the peak of Vietnam operations, each day of pipeline was worth $1.2 million for the Army alone. The 13-month pipeline would then require more than $450 million. This couldn't be afforded, so the Army provided attentive management, which gradually reduced the pipeline to its low of 6.5 months (106:146-7).

Maintenance of equipment other than aircraft faced pretty much the same problems described above. Facilities were necessary for support maintenance beyond the organizational level. Self-help was heavily employed in all Services although heavy construction support was obtained by contract, the Seabees, Army engineers, and Air Force civil engineers. Sometimes the units obtained Vietnamese buildings, such as old rice warehouses, and upgraded them with their own labor and equipment for maintenance use.

The equipment the United States gave the troops in Vietnam was as good as or better than any it had ever put in combat. But the lack of standardization was frustrating and led to great difficulties for maintenance and supply. For instance, there were 145 different sizes and types of commercial generators in use by the Army in Vietnam. Naturally, repair parts supply was difficult and so, too, was maintenance. Parts were hard to get and seldom were interchangeable—they fit one size and type only. The same condition existed with materiel-handling equipment and other items of equipment. The Army, in a concerted effort, reduced the 47 materiel-handling models to only 5 by late 1967.

The design of some equipment made it difficult to maintain in the adverse conditions of Vietnam. For example, the road wheel oil-fill plug on the Sheridan vehicle was located on the inside of the wheel. Someone had to crawl under the vehicle to reach the plug. In the monsoon season in Vietnam, this was impossible unless the vehicle was inside a building. The Sheridan's radiator also sucked up leaves and twigs that blocked the cooling and caused overheating of the engine. Many other like conditions existed and should be among the specific lessons learned from the Vietnam War (106:183).

Construction

Much of Vietnam was undeveloped when we began our buildup. There were, as we have several times mentioned, very few ports with adequate port facilities. The countryside was crisscrossed with small and large operations. Because of the dispersal of the Vietcong, there was need for a great number of bases in the outlying country. The existing airfields were sadly inadequate and had to be rebuilt or replaced. In addition, a great many more of varying sizes had to be constructed. Other logistics support areas were nonexistent. Roads and rail systems ranged from nonexistent to poor to acceptable but restricted. Cantonment areas did not exist.

The requirements exceeded the capacity of the military forces, so heavy reliance was placed on contract support. Thousands of civilian personnel employed by US contractors came to Vietnam to do their construction jobs. So, too, did a host of third country construction companies and their employees. Where possible, local Vietnamese contractors were also employed. Additionally, there was a lot of self-help construction done by the personnel of the units in country. There was a great need for joint service planning and coordination, but it was not well done, particularly at first. The Services once more found themselves competing for needed support when there should have been coordinated efforts (122).

The engineer personnel of the military services performed outstandingly in Vietnam. They did a superior job under the most difficult conditions and were often doing their construction work while active combat continued around them. The Navy's Seabees, the Army's Combat Engineers and Corps of Engineers and the Air Force's Civil Engineering, RED HORSE (rapid engineer, deployable heavy operations repair squadron) teams and Prime BEEF (base engineering emergency forces) teams were all noteworthy in this effort (106, 113, 122, 235,122).

The lack of wartime controls and priorities created a significant problem for the Service's engineers. The construction authorizations and funding continued as for peacetime. The Services were required to follow the same steps and processes for programming and budgeting as during normal peacetime congressional work. Officially, the United States had not gone to war or to emergency status so construction work had to follow the maze of bureaucratic steps involved in the laborious military construction procedures with resultant delays to obtain construction approval and funding in the combat areas (122:13, 113:184-5). It was a problem that should not have existed and should not again. Partly

because of this, the engineer official spent a lot of time designing and procuring prefabricated buildings that could be moved to Vietnam and rapidly erected. While frustrating, it was effective and did provide essential support for the forces in country.

The Navy was designated Defense Construction Agent for Southeast Asia contractor construction and design. This involved the Navy in priority assignments and project management for the kinds of facilities mentioned above. Large airbases had to be built before land-based aircraft could be used in military operations or logistics support. By 1968, eight major airbases, with 15 runways, had been constructed. Before the end, 200 additional airfields were also built and at least that many heliports. Further, large and small airports were also constructed in nearby Thailand. Additional large facilities had to be built for Army, Navy, and Marine Corps activities throughout the RVN and in many sites in Thailand.

The most pressing problem initially was the absence of adequate ports and port facilities. In World War II, the construction of port facilities received top priority, but for the Vietnam buildup, the top priority—by direction of the Military Advisory Command, Vietnam—went to airfields, supply roads, and railroads. It seemed obvious the roads and railroads would be of little value if the ports could not offload shipping; nevertheless, the priority went to the other construction. Various controls were established in Washington and in Vietnam to maintain order in and manage progress of construction. A construction *czar* was created by Secretary of Defense Robert McNamara and made responsive to the Commander, Military Advisory Command, Vietnam. His authority extended to setting of standards, passing on requirements, and control of military engineer units not assigned to major combat forces. A similar officer was also located on the Secretary's staff in Washington, and the bureaucracy was erected.

The Seabees were, like their World War II fathers, exceptionally competent engineering and construction personnel. The Navy depended on them for a great part of the initial naval construction of support and operational bases. Their accomplishments in forward areas and in the major bases were key to operational and logistics successes. They developed ports and port facilities; built airfields, heliports and airstrips; constructed and improved roads; put up cantonments and warehouses; built hospitals and dispensaries; dug wells; prepared missile sites; erected refrigeration storage sites; created water purification plants; built dairy products recombination plants; built messes and kitchens; installed pipelines and fuel distribution systems; and on and on. Their results were truly magnificent (113:180-193).

The Seabees and other engineer troops, as well as other military units in country, were also very active in civic action projects. While these did little to help the logistics support activities or the operational activities, they certainly deserve mention. US personnel built schools, bridges, hospitals, and resettlement villages. They dug wells and made arrangements for purified water. They taught the Vietnamese new skills—English, music, and anything else the Vietnamese thought would help them. Table 16 depicts this effort.

Action By US Forces in Vietnam

Schools	1,250+
Hospitals	175
Market Places	155
Roads (kilometers)	3,134
Churches	263
Dispensaries	422
Bridges	598
Dwellings	7100

(Examples, only)

Source: (106:vi)

Table 16. Civic Action Construction

The Air Force provided each of its bases in country with civil engineer support for maintenance, construction planning and programming, and onbase minor construction. However, the massive buildup of Air Force units far exceeded the capability of these small units so the Air Force deployed special military civil engineering teams.

Prime BEEF teams were constituted by requiring all US bases to organize their civil engineering units so that teams with a specified capability could be deployed to meet emergency conditions in the United States or overseas. The first Prime BEEF teams went to the RVN in August 1965 and were used to construct revetments for aircraft protection at Tan Son Nhut, Bien Hoa, and DaNang. Between then and December 1967, 50 such teams went to Vietnam on a temporary duty basis doing construction of hangars, water systems, sewer systems, and much more.

The RED HORSE units came to exist in recognition of the need for and the DoD-assigned responsibility for emergency repair of bomb-damaged airbases. When the Air Force was unable to obtain assurance of ready availability of other engineer forces, the Red Horse units were created. Six such squadrons were deployed with the first going to Cam Ranh Bay and Phan Rang in January 1966. Each was 400 men strong and equipped for combat engineering support of Air Force tactical units in the combat theater.

Aircraft protection from mortar and missile attacks was essential. The Air Force used revetments to reduce the vulnerability of aircraft. These were primarily prefabricated units built in the United States and erected in country beginning in December 1968 by the several construction sources obtainable. The prefabricated unit cost declined from the initial $9,600 to the final $3,700, and almost 2,000 of them were shipped to Southeast Asia. These revetments were also provided for the Navy at DaNang and Chu Lai (123: Sec H).

Pierced-steel planking or its aluminum alternate had been used in World War II and the Korean War for rapidly constructing runways and taxiways in combat areas. The planking served its initial purpose but caused much difficulty as it began to fold up, break apart, and sag on top of soft soil.

The breaking and bending created serious tire problems for aircraft and dangerous conditions when tires of heavily loaded combat aircraft were flattened while taxiing, taking off, or landing. The same conditions were found in Vietnam, causing many experienced engineers and logisticians to question whether the lessons of history were ever going to be taught or learned.

Army planning for troop construction in country was done in great detail. Construction control was, as we have stated, in the hands of the czar in the Military Advisory Command, Vietnam. That office also created standards that had to be met unless deviation authority was granted. Various standards for differing degrees of urgency were created. For example, the temporary standard included preengineered metal or painted wood buildings with modern utilities. Intermediate standards permitted wood buildings with limited utilities. Field standards included tents or wood buildings with minimal utilities (106:189).

From fiscal year 1965 through 1971, Congress authorized Army military construction funds of approximately $969 million for Vietnam. From 1969 on, an increasing percentage of the construction funds were spent on the Republic of Vietnam Army improvements such as maintenance depots, storage facilities, training centers, and communication stations. This was the official US position as the concept of phase-down began.

From Construction to Combat

In 1966, the Army began experimenting with a device that later came to be called the *Rome plow.* The name came from the fact it was manufactured by the Caterpillar people in Rome Georgia, and the fact it was to be used basically as a giant plow. It was, in fact, a large bulldozer equipped with a special plowing/cutting blade.

Vietnam was famous for its mass of underbrush and heavy growth. In many areas where the Republic of Vietnam Armed Forces (RVNAF) or the US Armed Forces wanted to erect a base or set up a defensive position, that undergrowth led to great difficulties and considerable danger. Obviously, the undergrowth provided great protection for the North Vietnamese or the Vietcong. Just as obviously, the growth meant difficulty for construction and security of buildings, fences, roads, or whatever was needed. Chemical defoliants could only do so much. They did not rid the area of stumps or root masses, and they did not show location of tunnels or caves. Burning was slow and required fuel supplies often not available. So the Rome plow was devised, and its use began.

The Rome plow could cut through trees up to 3 feet in diameter and could uproot and remove clumps of bamboo that often stymied other forms of clearance. Further, the bulldozer was so heavy it would set off enemy mines and, unless the mine was unusually strong, do so with no damage to the dozer. Enemy fire was of little consequence because the dozer's heavy metal was exceptional protection unless the enemy used antitank rocket grenades. The machines also flattened and eliminated most of the hazard from spiked traps planted by the enemy. So the Rome plow was a very effective construction vehicle, which also became a security weapon.

The plow was used to discover tunnels and underground rooms that greatly helped in reducing potential sabotage later. Also, they were used to clear roadways and camp areas. They were employed to clear security/freedom areas on both sides of heavily traveled highways. Usually, they would clear the undergrowth for 150 to 200 meters on either side thus affording those in transit some higher degree of safety.

There were two major problems with the Rome plow so far as use by the RVNAF was concerned. These were the 600-gallon-per-day diesel fuel requirements for each plow and the maintenance required to keep them serviceable. Parts were always a problem for the bulldozer, in particular, but became even more a constraint after US withdrawal from Vietnam.

The RVNAF learned to use the Rome plow in quantity. They would run them en masse (almost in a line) so as to get the clearance done quickly and allow the enemy minimal time to attempt their destruction. The plows could then be quickly released for use in other sites. It did take time to clear an area though because trees had to be uprooted and removed. They found that when the tree roots were left in the ground, new growth usually appeared, and the problems of undergrowth developed again. However, when uprooted and removed, the growth did not return so readily.

The Rome plow was another logistics introduction to warfare under specific terrain conditions. It was effective, but as with most technology advances, it also carried with it its own logistics support needs that added to the overall logistics requirements. This is another lesson we should learn from Vietnam.

Subsistence

The forces in Vietnam apparently ate well after the buildup and the establishment of facilities and support structures. The number of complaints about food was considerably reduced from the experiences of the Korean War and World War II. It was not uncommon at fire-support bases to have ice cream and eggs to order (106:198). There was extensive use of large refrigerators, refrigerator vans, and the always handy helicopter to ensure troops in the field almost routinely enjoyed garrison rations. The Navy, of course, continued its excellent messing on board the Pacific Fleet ships and provided equally good food service ashore. Wide use was made of provision ships to keep the fleet and shore units adequately supplied.

Initially, Army and Air Force troops got by with B-rations and the MCI (meal, combat, individual). Those units in established parts of the country like Saigon, Cam Ranh Bay, and Vung Tau received A-rations including fresh milk, vegetables, and fruit. This was later changed as refrigeration was made available and more fresh foods were sent forward. Fresh fruits and vegetables were received from the United States, Western Pacific countries, and in-country sources.

In October 1967, the Sea Land Corporation began providing refrigerator cargo service to South Vietnam. Four ships arrived in Cam Ranh Bay every 15 days. Each ship had 120 refrigerated vans and 530 dry cargo vans. The refrigerated vans were divided with 60 going to the Saigon area, 30 to Qui Nhon, and 30 staying in Cam Ranh Bay. Further distribution was made from each terminal.

Three recombining milk plants were constructed in the RVN for US forces. They provided a wide range of diary products including ice cream. Smaller ice cream plants (40 of them, in total) were brought into the country to provide ice cream as far forward as possible. For the most part, subsistence supplies were on the *push* supply system throughout the Vietnam War. The subsistence warehouses and supply points not only serviced US forces but also supplied other free world military assistance forces, officer and NCO open messes, and civilian contractor messes (106:200).

An additional ration was created to meet the tactical situation. This was the Long-Range Patrol Ration. It was a dehydrated, precooked ration available in eight menus. It was apparently highly acceptable to the troops. There was also another small patrol ration created of indigenous foods for those forces not accustomed to US meals.

Salvage and Disposal

Salvage and disposal should always be of concern to logisticians. The actual field of combat often does not lend itself to such action until after the battle has been ended and the area made safe for salvage and disposal teams. But much equipment and recyclable resources can be collected. An example occurred in 1965 when the Navy sunk two Vietcong junks delivering cargoes to the enemy. One was in 20 feet of water, the other in 30. Both were patched, raised, and towed to An Thoi where their cargoes of grenades, rifles, and ammunition were made available to the RVN (113).

We have before talked to the collection of shell casings, powder canisters, and other recyclable residue, following naval ship firing. This form of salvage and disposal has potential economic value and is generally practiced with skill by the Navy. Similar activity has been used by the Army and Marine Corps when large artillery shells are fired or when a battlefield is safe for scouring. The Air Force and Navy aircraft generally cannot reclaim shell casings because they are ejected in flight, fall to the earth, and are individually spread over vast areas.

Sometimes Navy vessels run aground and must be relieved either by towing or other strenuous salvage action. Rescue towing is relatively common and is not restricted to Navy ships. Many examples of ships that lost propulsion power being saved by rescue towing to the nearest port could be offered. They occurred in the Vietnam War, and the salvage received little notice. At other times, ships hit mines placed by the enemy and must be salvaged before they are destroyed by the sea. When this happens in entry channels to ports, the channels must be cleared so other ships are not restricted from use of the port. A small carrier, *USNS Card*, was sunk this way at Saigon in 1964 and later refloated, clearing the harbor, by Navy salvage experts.

An oddity of modern war is the recovery and salvage of downed aircraft. The large helicopters, like the CH-47 and CH-54, were often used in Vietnam to pick up other helicopters, liaison aircraft, and spotter aircraft. They were also used to pick up trucks and other large vehicles unable to operate in forward areas. These pickups were delivered to maintenance facilities in the rear areas where they were often returned to service or used for cannibalization for parts, again an economical effort.

As a military force settles in to an area, it will begin to generate excess property, which will require disposal. Therefore, property disposal must be an element of concern and planning for logistics. Sometimes the excess property can be returned to the United States for effective use in another environment or operational situation. Other times, the excess can be sold for a monetary return to the US Treasury. Then, too, sometimes it may be donated to the local government for its economic or educational enhancement. At any rate, disposal is a valuable and necessary function of logistics and was effectively pursued in the Vietnam War.

Security

One of the more critical aspects of the logistics effort in Vietnam was security; that is, security for logistics personnel, installations, facilities, equipment, and materiel. There were ambushes, rocket attacks, sappers, and assaults by Vietcong and North Vietnam Army forces that had to be repelled or deterred. Additionally, there was constant pilferage. All of this added up to the need for constant awareness of the necessity for strict security.

These factors were not always considered when planning for or designing logistics installations or facilities. Quite often, the designs and plans were essentially based upon conditions in the United States, which was entirely unrealistic for Vietnam. Further, there really were no *secure* rear areas because of the relatively easy insertion of Vietcong forces into any area of the country. Because of this planning inadequacy, personnel authorizations for logistics forces were not sufficient to man required security posts around the clock. Radios and portable communications gear were always in short supply, further hampering security efforts.

A wide range of actions by logistics leaders was taken to prevent or avoid sabotage and pilferage. These actions included:

- Frequent inventories.
- Continuous education of employees about what to be alert for in these areas of threat.
- Physical barriers with intrusion delay devices.
- Employee identification badges to control access to certain areas.
- Strict control of access to storage areas for sensitive items.
- Spot inspections.
- Spot personnel searches.
- Multilingual signs warning personnel.
- Strict accounting for all receipts and issues.

- Installing highly visible *US government* markings on property.
- High fencing around sensitive areas.
- Frequent practice alerts to ensure everyone knew where to go for the defensive position (106:34-5).

Truck convoys were regular targets on the mass of insecure highways in the country. Convoy commanders asked for and received military police escorts when such people were available. They also sought and received spotter support from artillery units on high ground, spotter aircraft, and other forces nearby. Where possible, military trucks and drivers were always used to haul base and Navy exchange supplies that were readily marketable commodities and highly desired by Vietnamese. Convoy protection included:

- Trip ticket control.
- Road patrols.
- Checkpoints.
- Radio reports of departures and arrivals at checkpoints.
- Strict accounting for load and unload times.
- Close liaison with RVN police agencies along the route.
- Armed security guards, when available.
- Armored vehicle escorts, when available.

The same attempts at security, in a different form, were required for ships and smaller vessels in the harbors and ports. They, too, were subject to sabotage and theft plus the occasional shelling and mortar fire from onshore enemy troops. All of this was particularly touchy with munitions storage and shipment activities. The munitions themselves were highly desired by the enemy and thus a major target. But more than that, the enemy knew how difficult it was for the United States to keep the munitions stocks at required levels and knew any massive destruction would seriously impact our operational capability. The greatest munitions danger was enemy sappers, rockets, and missiles, which could literally destroy not just the munitions but perhaps the whole installation.

Logistics security was a great problem in Vietnam. It will be in any future operational involvement in which the enemy has relatively easy access to our logistics areas—a lesson from the Vietnam War.

Morale Logistics

Our definition of logistics includes those elements of personnel care and management that might be classed as morale items. These would include mail, movies, radio, television, recreation, exchange supplies, and others.

Recreational facilities were created in great numbers around the major bases. Olympic-sized swimming pools and fine gymnasiums were constructed. Theaters and base/ship exchanges became fixtures with interiors much like those on any large US base. Ice cream and candy counters were available in these outlets. Lighted ball diamonds and tennis courts were built. Air-conditioned quarters were provided on some installations. Some installations arranged for Vietnamese or Thai maid service for the residents. Pizza parlors sprang up, and in some sites, deliveries were made to quarters. As in all modern wars, mail was very important to the troops so far from home. Huge quantities were delivered daily with most of the letter mail coming by air for fast delivery. The exchanges offered catalog shopping using the mail service for placing the orders or shipping the materiel purchased in the stores. Packing concessions were often provided to ready the purchase for mail. Post offices to rival the best of any other small US city were provided.

Libraries were very popular. The Navy established a 20,000-volume library in Saigon and six branch libraries in the areas of heaviest troop concentration. The Navy library also shipped consignments of magazines, newspapers, and some 60,000 paperback books to 750 field units (113:64). Similar libraries were provided Army, Marine Corps, and Air Force installations.

Educational services were provided as well. These included night classes conducted under the auspices of the University of Maryland and other schools. Correspondence courses were available, and the General Educational Development tests were administered regularly. Radio and television broadcasts were provided, and sometimes there were educational offerings on those media as well as usual entertainment offerings.

We earlier mentioned the short 12-month tour in country and the mid-tour rest and recuperation break at government expense. These, too, must be considered in the logistics of morale for the Vietnam War.

All in all, the morale services were extensive and expensive. Considering the mood of the people back in the United States, the absence of war or emergency declaration, and the unpopularity of the Vietnam War, all of this might be considered necessary. However, it cost a great deal of money and a great deal of additional support personnel, facilities, and construction. There can be honest doubt of the need for or the wisdom of such extensive materiel concern for morale in a war zone.

Other Logistics Support

Other logistics support services included graves registration, laundry, drycleaning, decontamination, and others. The listing would be too much for us to pursue in totality.

Graves registration was conducted by selected people at collecting points. They ensured identification certificates were in order, the human remains were clean, documentation was correct and personal effects were properly recorded and safeguarded. The remains were then transferred to one of the in-country mortuary centers. The personal effects depot consolidated the receipts from the collecting points, plus any items recovered at the mortuary, and forwarded them all to the United States for delivery to the next of kin.

As early as 1968, search-and-destroy planning was underway for locating US bodies in the combat areas. A central file bank was maintained for all who were classed missing and/or *body not recovered*. The search has been as continuous since then as the Vietnamese government allows.

Bath services were provided to all US and free world military assistance forces in Vietnam and Thailand. Early in the buildup, this service was provided by fixed or improvised facilities. As the number of people in country increased, mobile bath units were organized and operating by 1968. These units usually offered hot and cold showers from their fixed or improvised facilities but only cold from the mobile. They operated 16 hours per day and at peak were providing more than 125,000 showers per week. Later the number of units was increased, and the weekly shower load rose to more than 400,000 (106:204-6).

Decontamination was not required for its planned usage. There was no chemical warfare in Vietnam other than the defoliants and similar materiel used by both sides. However, decontamination units cooperated with the bath units and helped to increase the capability of that service.

Laundry and dry cleaning was provided on most major bases of all Services. Most of the need was for laundry facilities, with far less need for dry cleaning. At the peak, the Army estimated the laundry requirement was for more than 7 million pounds per week. Local national women frequently offered laundry service, which seemed more popular than the GI laundry service and decreased the workload of the *official* service. Smaller units were equipped with mobile laundry units. The larger units had fixed facilities. Always, of course, there was a need for electrical power and, in the case of the larger units, specific people to operate and maintain the laundry and drycleaning equipment and systems.

Before we leave this area, we should mention that a great deal of the logistics effort of all the Services was expended in supporting the RVN military forces. We provided them with almost everything we provided our own troops and a lot that was peculiar to their specific needs. Although it is not fair to lump it all together under other logistics support, it must be done to avoid lengthy listings of support rendered to the RVN.

Summary

Logistics support in the Vietnam War, although expensive, was effective. In Vietnam, alone, we emplaced more than 2 million US military personnel and spent more than $4 billion on construction. We created 7 deep water ports, 8 major airfields, and more than 200 minor airstrips; erected more than 11 million square feet of covered storage space; and created about 2 million square feet of refrigerated storage; constructed hospitals with more than 8,000-bed capacity; and consumed more than 163 million barrels of petroleum products. All of this was just in Vietnam, and there were more such statistics from Thailand, Guam, and other sites in the Pacific (122:3-4). Combat needs were met but often at considerable expense and waste.

The Vietnam War has been classed as our first air-conditioned war (185). It was called that because of the conditions that occurred. The unpopularity of the war at home, coupled with the short tour in country, made officials look for ways to keep the personnel in country satisfied. Large exchanges were constructed. Olympic-sized swimming pools and lighted baseball diamonds were created. In many cases, air-conditioned housing was provided. Vietnamese women provided maid service at low cost. The R&R trip made the combat purpose almost secondary at times.

All of this helped morale but also created its own support requirements. Large numbers of people and huge quantities of materiel went into the creation and maintenance of these accommodations. Yet for those involved in the actual dirty combat, these good life features did not exist, and life was generally miserable. Some consideration for the inequalities of this form of mixed quality of support must be provided in logistics planning for any future US military involvement anywhere in the world.

Nevertheless, the overall logistics effort was successful. By all accounts, combat commanders were generally never mission incapable because of lack of support. Combat unit support needs were met. The logistics program, like that in our history of earlier combats, was effective but wasteful and expensive when it could have been considerably less so. We should be alert to that factor.

In January 1973, a peacetime treaty was signed in Paris by the North Vietnam government, the Republic of Vietnam, and the United States. Great hopes were held for the future of a free and independent RVN, but it did not come to fruition. The North Vietnamese continued to intrude on RVN territory, consistently violated the terms of the peacetime treaty, and continued sporadic but severe fighting. They gradually came farther and farther south until finally Saigon surrendered on 30 April 1975. The United States began its evacuation of Vietnam with an *Orphan Airlift* trying to get as many orphaned children out of the war-torn country as possible. Then, US troops and citizens were airlifted out of Saigon, and the Communist North Vietnamese assumed control of the entire country. Ho Chi Minh's goal of a united country under Communist rule had been attained. The 10-year effort by the United States to hold Vietnam failed.

Some Logistics Lessons from Vietnam

There is no consensus about the lessons from Vietnam, but these, among many others, come to us from that 10-year experience:

- If the United States is to be engaged in combat, defending itself or supporting another country, it should identify that action as war and act accordingly. Politically, economically, and socially, the country should go on a war footing and dedicate itself wholeheartedly to winning as quickly as possible.
- Logistics planning for potential war absolutely must be done in peacetime. It cannot be merely a rehash of the plans finally developed for the last war. Further, the plans must be constantly exercised and corrected as conditions and technology change. We certainly should have learned from our three most recent wars that the absence of

peacetime logistics planning creates time-consuming and expensive problems in wartime. We may not be able to last through that the next time.

- We must work to reduce unnecessary logistics support requirements and concepts. We probably will not be ale to afford another air-conditioned war—nor should we. We must learn to provide essential support to our combat forces and reduce the number of support forces and quantity of support supplies in combat areas.
- There is a great need for increased joint planning for common logistics support among the Services. Peacetime operations should be preparations for war, so we probably should be thinking of more commonality and standardization of supplies, processes, and equipment wherever practical.
- Industrial mobilization planning is vital. It must be cooperative planning among the Services and with the industries involved. Each must understand its role in the event of mobilization. We must have the support of industry. We must employ all the mobilization strength we can muster when we decide to enter combat. We must call combat war and act accordingly with whatever economic and production controls and governances might be necessary.
- Munitions stockpiling is essential. Those materials cannot be readily obtained in huge quantities in the marketplace. Therefore, we must always be prepared with sufficient stocks to meet our estimated combat needs until munitions production can catch up.
- There must not be a defined 12-month tour in a combat area again. That tour length is dysfunctional and expensive. We must accept the fact of war when it comes and accept we may have to suffer in long combat area assignments in order to win. The personnel turbulence of such short tours cannot be afforded.
- In an undeveloped country, the provision of ports and port facilities should probably have top construction priority until the support logistics can be entered through those ports. After that, priority decisions for airfield and other combat needs may achieve higher urgency. Our experience in all wars to date reflects that more than 75 percent of logistics supplies move by sea transportation. We cannot afford to forget that.

Chapter Eight

The 1970s and 1980s: After Vietnam

The years following Vietnam saw a growth in US military capability, readiness, and sustainability. Congress and the citizens were unusually free with dollars for defense, and defense budgets were exceptionally large for peacetime. In fiscal year 1984, budgets were exceptionally large for peacetime. In his fiscal year 1984 Annual Report to Congress, Casper Weinberger, Secretary of Defense, related to the gain in defense capability. He mentioned the military logistics system as responsible for providing the requisite support to enable US military forces to deter aggression or, should deterrence fail, successfully conduct combat operations. Therefore, he said, logistics plans, procedures, and systems employed in peacetime must be equally employable in a wartime environment and capable of executing the wartime mission on short notice (305:283).

Secretary Weinberger mentioned in his report some statistics to indicate the scope and size of the logistics effort. US military forces were operating at more than 500 major installations in the United States and 250 installations overseas. The then current active duty military strength was 2.1 million men and women. There were about 1 million in the Reserve forces. The worldwide military logistics system consisted of, for example, 30 wholesale supply depots, 9 ammunition storage depots, 19 inventory control points, 35 depot maintenance facilities, 197 wholesale petroleum storage facilities and pipelines, and 115 ocean and air terminal facilities (305:283).

Planning, too, received increased support and attention in the late 1970s and early 1980s. Increased attention was given to planning in each of the Services as well as in the Joint Chiefs of Staff and the Department of Defense. For example, in September 1980, the Joint Chiefs of Staff published JCS Publication 21, *Mobilization Planning*, to guide and encourage preparatory activity for potential mobilization (121). The Air Force, in another example, began a series of annual meetings in 1980 for the purpose of looking ahead in logistics. Biennial publication of the *USAF Long-Range Logistics Planning Guide* was of significant help to logistics and mobility planners at all levels (255). On 1 August 1985, the Air Force Systems Command began Project Forecast II, which was directed toward identifying the technologies of the first decade of the coming new century (219).

Planning activism had really begun in the Office of the Secretary of Defense, and the staff elements of the Department of Defense, as a result of the 1961 Hitch and McKean book, *Economics of Defense in the Nuclear Age*. When Robert McNamara was appointed Secretary of Defense by President John F. Kennedy, it impressed him greatly and influenced his decision to create and implement the planning, programming, and budgeting system (PPBS) in the Department of Defense. This effort involved a number of guidance documents, including one for logistics. Initially, the PPBS efforts were highly centralized in the Department of Defense. Ultimately, the efforts were decentralized to the military departments in the mid-1970s. The most important element of PPBS was probably the requirement for the 5-year planning horizon, which demanded each military department and all its elements do some thinking about the future (97).

Industrial Mobilization

Unfortunately, not all was successful. Industrial mobilization did not receive the support it warranted. The Industrial Preparedness Planning Program was intended to develop, cooperatively with industry, a plan for the production of wartime requirements of certain supplies and equipment. It was not adequately funded, did not receive adequate priority, and has not succeeded. The US defense industrial base declined as companies found less and less defense contracting suitable or available. Smaller companies dropped out of defense contracting because they were unwilling to put up with excessive government administration and paperwork requirements. Much of defense needs had to be met—and do now have to be met—from foreign sources and suppliers. The potential danger of this is obvious, particularly when the site of many of those suppliers is noted as being very close to Soviet military capability or political influence (39).

The later years of our review have been difficult ones, in many ways, for the defense industries. Contract money for weapons acquisition and research and development has gone up and down with little sense of long-range direction. As mentioned before, many smaller companies chose not to deal with the federal government because of the massive paperwork and the bureaucratic processes involved with contracting. Further, there were great numbers of corporate mergers that changed the face of industry and also changed the product line of many.

Since the end of World War II, Japan, Germany, Italy, and other countries had successfully rebuilt their economies and

their industries. The same good fortunes had been experienced by South Korea following the Korean War. Other countries of the Pacific Basin were doing equally well. They began producing high-quality, high-quantity, low-cost products and offered to do the same for the Department of Defense. They offered significant competition in the United States and around the world. In many instances, the foreign products displaced US products, further reducing our industrial base and lowering our overall defense mobilization base.

For some of the smaller US businesses, the foreign competition caused them to explore other business opportunities, including undesirable contracting with the federal government. Some of them, very frankly, said it was better than bankruptcy. Nevertheless, a number of planners and thinkers are concerned about the decaying US industrial base. They worry about whether the United States has retained sufficient industrial mobilization capability for our national defense.

Air Force Acquisition Logistics

In 1976, the Air Force Logistics Command created the Acquisition Logistics Division (ALD) at Wright-Patterson AFB, Ohio, to work closely with the Air Force Systems Command in weapon system and equipment established from the personnel assets of the ALD to work in each major system program office of the Air Force Systems Command. The job of the DPML was to assist the program manager in obtaining maintainable and supportable weapon systems and equipment. The DPML was to be responsible for all logistics aspects of new system and equipment acquisition.

Further action to unite acquisition and follow-on logistics support came in 1982 when the Air Force Chief of Staff directed the Air Force Systems Command to establish a Directorate of Acquisition Logistics in the command's headquarters. The function of the new directorate was to interact with the Air Force Logistics Command to ensure logistics factors were fully considered in design and production of all new weapon systems and equipment.

Equipment Prepositioning

The Army, recognizing the need for immediately available equipment for deploying forces, began a prepositioning process in the early 1970s. This was directed toward having fully combat capable equipment available for issue immediately to arriving support forces from the United States. This method of prepositioning was called Prepositioning of Materiel Configured to Unit Sets (POMCUS). POMCUS equipment was controlled by the Combat Equipment Group, Europe and stored in 83 humidity controlled warehouses. There were about 2 million items in the NATO POMCUS valued at approximately $1.2 billion. Oversized equipment or low cost items were stored outside or in regular warehouses, but all tanks, armored personnel carriers, self-propelled artillery, and most wheeled vehicles were stored in the humidity-controlled warehouses. Care was taken to ensure rubber seals did not dry out and the metal surfaces did not rust or corrode. The equipment was frequently exercised and maintained with all required modifications installed as directed.

The POMCUS process in Europe worked. For example, on 8 September 1978, the 2d Battalion, 37th Field Artillery, Fort Sill, Oklahoma, was alerted for a surprise, no notice, emergency deployment to Europe to take part in Exercise Certain Shield. The battalion left the United States on 12 September and in less than 8 hours following arrival could fall out with fully functional POMCUS equipment.

POMCUS worked well when access agreements existed with foreign countries. But not all countries permitted that access. For example, many of the Southeast Asia and Persian Gulf countries did not permit access but preferred to retain their *equal proximity* policy, keeping an equal distance from both the United States and the USSR. Therefore, a different method for meeting needs was required.

In August 1979, Secretary of Defense Harold Brown initiated the Maritime Prepositioning Ships program for the Marine Corps. The program actively began in 1983 and will not be completed until 1987. When completed, it will provide prepositioned equipment and supplies aboard 12 ships for three specially organized Marine amphibious brigades, each of about 16,500 men. In 1985, there were 17 ships of a near-term prepositioning effort at Diego Garcia. Their cargo included water, petroleum products, equipment, subsistence stocks, ammunition, and other supplies. These were intended for one Marine amphibious brigade and early deploying Army and Air Force units (155; 218).

The Marines and the Navy, principally, have also begun prepositioning equipment using ships stationed at Diego Garcia in the Indian Ocean. The Air Force and the Army have some equipment in that area either on ships or on shore. The intention is to have essential initial equipment and supplies near at hand for mobilization in the Pacific Basin, Indian Ocean, or Middle East. The prepositioned supplies/equipment would greatly reduce the pressure on airlift and sealift from large-scale early deployment of forces.

Airlift

Airlift was a principal concern, too, through the years after Vietnam. It was generally recognized that our military airlift capability and capacity would not be sufficient for a national emergency involving heavy equipment of forces and continuing resupply for them.

The Civil Reserve Air Fleet was designed to provide the Department of Defense with commercial airlift augmentation when required. The CRAF had been established in 1952 as a result of an airlift study panel created by President Harry Truman. The CRAF was composed of civil air carriers who contracted their aircraft and some of their operating and support people and facilities to the Military Airlift Command (MAC). MAC manages the program for the Department of Defense (47:1).

There are three stages of CRAF that allow for tailored response to contingencies.

- Stage I may be called by the commander-in-chief, Military Airlift Command. It is a minor contingency support stage. It would be used to call up CRAF aircraft to fly MAC channel routes if all MAC's military airlift were required for contingency military movements.
- Stage II can be activated by the Secretary of Defense and would be a significant increase in capability over Stage I. The carriers would have 24 hours in which to provide their CRAF support just as in Stage I.
- Stage III could be activated by the Secretary of Defense if a national emergency were declared calling for full mobilization of our military forces. The carriers would have 48 hours to provide their support.

As an example of capacity increase, Stage I could provide about 6 million passenger miles per day while Stage II could provide 13.2 million and Stage III about 144 million (9:9).

The carriers are being financially assisted in their purchases of new wide-body convertible aircraft as a part of the CRAF enhancement program. The new aircraft can be used for passenger or cargo requirements with minimum effort for reconfiguration (9:12; 47). The costs of the program are considered small in relation to the increased airlift capacity for national needs.

Further consideration of airlift needs was evidenced in the Air Force by the continuing requirements for rapid service for critical and high cost spare parts. LOGAIR, begun in 1954, continued to grow in capability and effectiveness. It was created to move spares quickly to CONUS operational command units and to move materiel between the air materiel areas (later called air logistics centers) of the Air Force Logistics Command. The contractors flying LOGAIR converted from the earlier C-46 and C-47 aircraft to the propjet Lockheed L-100 Hercules and L-188 Electra and, later, to some all-jet aircraft. System capacity was thus increased as was schedule reliability. Although the cost of LOGAIR is sometimes thought high (in excess of $75 million per year), its benefits are great, and it does seem to offer low item movement cost. It was estimated in 1981, for example, that LOGAIR cost less than $600 per ton moved. It was stated that was lower than commercial airlift could provide (4:47).

Joint Logistics Commanders

Concern about joint Service activities caused the commanders of the Naval Materiel Command, Air Force Logistics Command, Air Force Systems Command, and Army Materiel Command to begin in 1966 to periodically meet. Their purposes were to air problems and increase coordination. This came to be known as the Joint Logistics Commanders (JLC). Through their meetings and their emphases, they have done much to ease tensions, increase efficiency, and raise effectiveness. The JLC was not and is not, an officially recognized policy-making body, but it obviously has clout and influence. Anytime 16 stars get together and jointly agree about something, others will listen and most often agree. The four commanders meet behind closed doors to overcome bureaucratic problems. The JLC still functions effectively after almost 10 years of life (20).

Air Force Logistics Doctrine

In 1980, the Air Force Deputy Chief of Staff for Logistics and Engineering expressed concern about the lack of current logistics doctrine in the Air Force. The latest document on the topic was the 1968 issue of Air Force Regulation 400-2, *Air Force Logistics Doctrine*.

A development to fill this void was assigned to the Air Force Institute of Technology, School of Systems and Logistics. Lieutenant Colonel Richard V. Badalamente, a member of the faculty, volunteered for the task and developed a draft logistics doctrine publication for the Air Staff (14). Unfortunately, the draft publication did not receive staff support and was not published by the Air Staff. However, continued effort was applied to the topic, and some changes were made in Air Force doctrine to accommodate logistics.

In late 1985, an Air Staff officer, Lieutenant Colonel William T. McDaniel, Jr, developed a logistics doctrine publication, which was being staffed for coordination and publication at the end of the year.

Maintenance and Supply

Air Force maintenance and supply continued to operate under the standard base procedures but with growing concern about those systems and procedures. The USAF aircraft maintenance system had begun in 1959 with the publication of AFM 66-1 and had remained basically unchanged except for minor updates and corrections. The supply system was much the same. Yet the Korean War and the Vietnam War had indicated that the specialized and centralized maintenance and supply systems were perhaps not the best for all missions and types of aircraft. In March 1966, the Air Force began development of a new maintenance management system identified as the Maintenance Management Information and Control System (MMICS). This work was directed at taking advantage of the availability of high-speed computers. The computers were expected to help maintenance managers make more effective use of resources to perform the mission and provide data for off-base use by the major air commands, contractors, Air Staff, and Department of Defense.

The new MMICS was essentially a data-generation and use system based upon the computer and a network of terminals. Much of the management of maintenance was similar to that of AFM 66-1. The initial test began 1 December 1971 at K. I. Sawyer AFB, Michigan. It was closely followed by the Air Force Audit Agency, which helped to further develop and grow the MMICS processes. Auditors supported MMICS but found faults in it which were immediately corrected by Air Force action (345). Development and testing continued until a decision was made to implement MMICS throughout the Air Force. That implementation began in February 1973 in increments. The costs for the program were estimated at $28.5 million through fiscal year 1981 (160:27).

In June 1975, the Air Force began a long-range and large-scale effort for improved maintenance. It was directed and controlled by the Air Staff Director of Maintenance Engineering. The project involved working membership from every major air command, the RAND Corporation, and the Air Force Institute of Technology. It was identified as the Maintenance Posture Improvement Project (MPIP) and was charged with developing ways to perform required maintenance with lesser numbers of personnel without compromising safety. Specific tasks included, among others:

- Organizational structure of maintenance.
- Maintenance manpower use.
- Training of maintenance personnel.
- Modernization of support equipment.
- Dispersal of supporting shops.
- Hardening of maintenance facilities.

Major air commands had been experimenting with alternative maintenance systems since the Korean War and since their more recent involvement in the Vietnam War. One alternative, called Commando Thrift, involved elements of the Pacific Air Forces in 1974. It was designed to validate an on-equipment/off-equipment concept. On-equipment maintenance was that made to the aircraft to service, repair, and remove and replace components. Off-equipment maintenance was performed in a specialized repair center to repair, modify, and calibrate components and equipment.

The test involved the use of a technical repair center on Kadena Air Base, Okinawa, to support the on-equipment operations of a tactical group on Taiwan. Reparable assets generated on Taiwan were airlifted to Kadena for action and airlift return. This concept reduced manpower and equipment needs of the tactical group but slightly increased those of the technical repair center. The test was considered successful (22:75-80).

In 1975, also in the Pacific Air Forces, another test was conducted. It continued the on-equipment/off-equipment concept but expanded the scope greatly. The technical repair center became known as the Centralized Intermediate Repair Facility (CIRF) and remained at Kadena Air Base. Now, though, it provided off-equipment, engine, and avionics support to three fighter wings. One was located on Kadena, a second at Kunsan, Korea, and a third at Osan, Korea. The three wings were restricted to on-equipment maintenance to service equipment, troubleshoot problems, make on-equipment repairs, or remove and replace parts and components. All off-equipment maintenance requirements were airlifted from Korea and trucked on Kadena to the CIRF for action. This proved successful. By early 1977, it had been expanded to include supply functions under a larger structure known as the Centralized Intermediate Logistics Concept (CILC). On 1 May 1977, Pacific Air Forces published Programmed Action Directive 77-6 expanding the CILC operation to include Clark Air Base, Philippine Islands, under the support umbrella of the CIRF at Kadena (254:76-7).

The success of the Pacific Air Forces test programs created interest in other areas of the Air Force. Soon after the initiation of the CIRF test at Kadena, the US Air Forces in Europe began similar tests with equally promising results. Their successes, coupled with those of the Pacific area, made the CILC operation a major recommendation of the Maintenance Posture Improvement Program for overseas tactical fighter units.

Meantime, in the United States, the Tactical Air Command, prompted by its deployment and mobility missions, had begun its own testing in September 1974. As the command evaluated its wartime and contingency requirements, it became obvious the sortie production capability of maintenance might well be the command's limiting factor. The Israeli Air Force had generated an amazingly high sortie count during the Yom Kippur War in October 1973 flying much the same aircraft as TAC. Therefore, the TAC test was based upon the maintenance organization and procedures of the Israeli Air Force. This came to be known as the production oriented maintenance organization (POMO).

A joint study team from the Air Staff and the Tactical Air Command visited the Israeli Air Force. They decided the Israeli Air Force sortie production capability came mostly from a slightly different organization and responsibility arrangement.

Personnel who performed maintenance on the aircraft were assigned to the flight line and not to specialist shops. There was a lesser degree of specialization on the flight line, and all maintenance personnel worked together for the launch and recovery of fighter aircraft. This was considered of great potential for USAF fighter operations, which depended on rapid sortie turnaround and high-surge capability.

The MPIP steering group, flag level officers of the major air command, agreed this concept had high potential for fighters but likely not as great for other types of mission aircraft. Accordingly, they agreed to standardization of aircraft maintenance within commands rather than strict standardization throughout the Air Force (22:78).

The test of the POMO concept was conducted using the entire wing of F-4E aircraft at MacDill AFB and one flight of nine F-15 aircraft at Luke AFB. The test was deemed successful. The new POMO concept was adopted as the TAC standard. Additional testing was soon underway with the tactical fighters in Europe and the Pacific. Ultimately, the three commands agreed to a certain degree of commonality to enable rotational units to accommodate readily to command maintenance directions. Through it all though, the POMO concept remained the basic guide for tactical fighter aircraft maintenance.

Similar conceptual changes were developed for supply support. The Tactical Air Command initiated Combat Oriented Supply Support (COSS). This concept reduced paperwork and decreased supply reaction time for maintenance needs. It accommodated to the POMO organization and responsibilities. TAC began the search for high-speed, high-memory, lightweight, portable supply computers that would permit in-the-field operations. Significant assistance was obtained from the Air Force Data Systems Design Center and Logistics Management Center, both at Gunter AFS, Alabama. The Data Systems Design Center assisted in paper and data-processing

reductions while the Logistics Management Center assisted in concept and procedural improvements. The basic idea of COSS was adopted for tactical fighter operations in the United States, Europe, and the Pacific.

A Matter of Concern—Strategic Stockpile

No nation has unlimited resources. No matter how well-intentioned the nation's behavior, it still must work within the constraint of finite resources. Then, too, the nation must bear in mind that many of the resources it needs to reach its goals must be obtained from sources outside its own boundaries. It should immediately be obvious that some of those sources outside the national boundaries might not always be friendly or cooperative. Thus, a significant problem involving national survival presents itself

The United States faces that problem today. It has been recognized as a problem since before World War I, and some legislative actions were taken to provide for a strategic or national defense stockpile of selected minerals. However, over the years, the stockpile has been greatly neglected, and we have a dangerous condition. The United States is solely—or mostly—dependent upon foreign sources for many modern technology minerals. We are living a hand-to-mouth existence with these minerals. We have set a course depending upon continued shipments for our national defense needs. We have not adequately provided for national emergencies such as war or the stoppage of supplies.

Without question, the United States is the strongest nation in the world. It has the blessings of a wonderfully productive land area and population, a strong military, a booming economy, political stability, and peacetime intentions toward the remainder of the world. Yet its agricultural, industrial, technological, and economic capabilities remain healthy and strong only if they have the resources with which to function. Prime among those resources are the minerals from foreign sources so vital to our productive efforts. The productive elements of our society cannot function effectively very long without continued availability of those minerals, yet we seem unwilling to pay the price for maintaining a stockpile to sustain us in time of emergency. Our existence as the light of true freedom in the world is threatened by our inactivity.

We are properly proud of our standard of living in our free society. Yet that standard of living could likely not be sustained without availability of minerals and petroleum. If our supply source for manganese, chromium, platinum, and cobalt (to name just four) were to be cut off, we would suffer drastic reductions and limitations in agriculture, manufacturing, transportation, electronics, construction, aerospace, and so forth. Without a doubt, our vaunted economy and strength would be seriously harmed as millions of our people lost jobs and prices began a raging climb to record heights. Just the loss of those four minerals could create unsolvable political and economic problems in the short run and maybe even lead to the end of capitalist freedom as we know it.

Yet we seem unwilling or unable to move to ensure an adequate stockpile of these critical materials for our national defense. Of the 36 nonfuel minerals declared essential to our industrial base, 22 are dependent almost totally on foreign sources. The worst facet of this, though, is the fact that many of the countries supplying us with these critical minerals are Communist, Communist-aligned, or politically unstable. World War I and World War II drove home the point of criticality and caused initial stockpiling actions to be taken. Yet the lessons of those two wars seem to have been forgotten, and the US national defense stockpile has been unwisely neglected.

The current stockpile consists of 93 commodities. Eight of them are minerals; the others are agricultural products. Sixty-four of the mineral commodities have specific stockage goals, and most have nowhere near the goal on hand. The current stockpile is valued at a little more than $11 billion. It is stored in more than 100 sites around the United States. It has been estimated in order to reach stockpile goals would require expenditures of an additional $10 billion. At current rates of appropriation (only $359 million has been spent since 1979), it would take more than 100 years to attain existing goals, without considering the loss due to deterioration and so forth.

Some of the minerals, our dependency, and the primary sources of US supply are shown in Table 17.

Sources and US Dependency

	Percent	
Bauxite	96	Surinam Guinea Jamaica
Beryllium	80+	South Africa Brazil China
Chromium	77	South Africa USSR Philippines Yugoslavia
Cobalt	96	Zaire Zambia Japan Canada Belgium
Corundum	100	South Africa
Manganese	99	South Africa Australia Brazil Gabon

Table 17. Strategic Stockpile Minerals

Epilogue

History continues. It is being developed as you read this page. As we review the events of the past, we cannot help but be impressed with the changes in the world. Our brief review of the history of US military logistics from 1935 through 1985 has left much uncovered. Yet we can see that the intricacies of logistics have become more important to military success and more constraining. Strategy and tactics are even more dependent on logistics than ever before in man's history. The weaponry of war in just these 50 years has become far more complex and demanding. Each element of support, in part due to complexity and sophistication, has become more expensive and more difficult to provide. It stands to reason, then, that we should do all we can to avoid waste and loss. How better to do that than by the review of history.

As we have worked our way through these 50 years, I hope you have noted the number of times the same problems seem to exist. Certainly, logisticians should be able to learn of these problems and work to prevent their continuing recurrence. I am personally convinced that the study of our logistics history is vital to all who now work in logistics and all who will work in the profession. We certainly should be ensuring these major problems are not repeated in the future.

While this review has treated logistics, we should keep in mind that military operations exist only through the combination of strategy, tactics, and logistics. Combat and logistics go hand in hand. But each affects the other. Logistics affects combat. Combat affects logistics. We cannot say that logistics wins wars, but we can certainly say that wars are not won without logistics. The relationships between combat and logistics are complex and interlaced. An appreciation of these relationships is essential to a true understanding of warfare because both are a part of the whole.

Because of the limited length of this presentation, there have been many details omitted and much of interest glossed over. Yet it merits review and analysis. Therefore, you are urged to use the bibliography to pursue the history of US military logistics more avidly and thoroughly than we have been able to do in these pages. Many of the publications cited will also have bibliographies, and I urge you to use them for learning valuable information.

I hope I have reflected credit on the hundreds of thousands of men and women who have labored in the fields of logistics. They have performed with grace and dedication doing their often thankless jobs. Most of them received little recognition for their efforts. Yet they did succeed in supporting our combat forces so we could win our battles. It does seem unfortunate that our political mentors perhaps caused all this to go for naught in making decisions, which often cost us the war.

There are important lessons to be learned from our history of military logistics. I hope they are learned and remembered as we plan our readiness for national defense.

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Fairborn, Ohio
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Glossary

A

ACA	airlift clearance authority
ADAGG	arrival-departure airfield control groups
AEF	American Expeditionary Force
AFALD	Air Force Acquisition Logistics Division
AFIT	Air Force Institute of Technology
AFLC	Air Force Logistcs Command
AFM	Air Force Manual
AFRES	Air Force Reserve
AFSC	Air Force Systems Command
AGS	aircraft generation squadron
AKA	attack cargo transport
ALD	Acquisition Logistics Division
ALS	Advanced Logistics System
AMC	Air Materiel Command
AMP	avionic modernization program
ANG	Air National Guard
ANZUS	Australia, New Zealand, United States
APO	Army post office
APOE	Aerial ports of embarkation
APA	attack personnel transport
APD	converted destroyer transport
ASC	Air Service Command
ASF	Army Service Forces
ATC	Air Transport Command
AUTODIN	Automatic Digital Network
AVG	American Volunteer Group

B

BUD	battle dress uniform

C

CAP	Civil Air Patrol
CBI	China-Burma-India
CCC	Civilian Conservation Corps
CIA	Central Intelligence Agency
CILC	Centralized Intermediate Logistics Concept
CINCPAC	Commander in Chief, Pacific
CIRF	Centralized Intermediate Repair Facility
CLSS	combat logistics support squadron
CMS	Conventional Munitions Systems, Inc
CMSS	congressionally mandated mobility study
CNAC	China National Aviation Corporation
COB	*collocated operating bases*
COMO	combat oriented maintenance organization

ComZ	communications zones
CONEX	Container Express
CONUS	Continental United States
COSS	Combat Oriented Supply Support
CRAF	*Civil Reserve Air Fleet*
CRS	component repair squadron

D

3D	Delayed Desert Damage
DCSC	Defense Construction Supply Center
DDRV	Defense Depot, Richmond, Virginia
DFSC	Defense Fuel Supply Center
DLA	Defense Logistics Agency
DMES	Deployable Mobility Execution System
DMMC	Division Material Management Center
DMZ	demilitarized zone
DPML	Deputy Program Managers for Logistics
DPSC	Defense Personnel Support Center
DSA	Defense Supply Agency
DTS	Defense Transportation System

E

EDS	European Distribution System
EMS	equipment maintenance squadront
EOD	explosive ordnance disposal
ESOC	Emergency Supply Operations Center
EUSAK	Eighth Army in Korea European Distribution System

F

F^3	Form, fit, and function
FAST	forward area support team
FDLS	fast deployment logistics ships
FEAF	Far East Air Forces
FEC	Far East Command
FOB	forward operating base

G

GNP	Gross National Product
GP	general purpose
GPS	global positioning system
GSA	General Service Administration

H

HET	heavy equipment transporters
HF	high frequency

I

ILS	instrument landing systems
IPPP	Industrial Preparedness Planning Program
IROS	increased reliability of operational system

J

JCCP	Joint Casualty Collection Point
JCS	Joint Chiefs of Staff
JLC	Joint Logistics Commanders
JLCOM	Japan Logistical Command
JLRB	Joint Logistics Review Board
JMSNS	Justification of Major System New Start
JSTPS	Joint Strategic Target Planning Service
JTB	Joint Transportation Board

L

LAO	logistics assistance office
LCA	landing ship, assault
LCC	life-cycle costs
LCI	landing ship, infantry
LCP	landing ship, personnel
LCT	landing ship, tank
LORAN	loong-range navigation
LOTS	logistics over-the-shore
LP-I	Laboratory Problem I
LP-II	Laboratory Problem II
LRU	line replaceable units
LSA	logistics support analysis
LSD	Landing ship, dock
LSL	Logistics Systems Laboratory
LST	landing ship, tank

M

MAC	Military Airlift Command
MACV	Military Airlift Command-Vietnam
MAGTF	Marine Air Ground Task Force
MASH	Mobile Army Surgical Hospital
MATS	Military Air Transport Service
MEAR	Maintenance Engineering Analysis Record
MEDLOG	Medical Logistics
MHE	materiel-handling equipment
MILSTRAP	Military Standard Requisitioning and Issue Procedures
MMICS	Maintenance Management Information and Control System
MOB	main operating bases
MORE	meals, off-the-shelf, ready-to-eat
MPIP	Maintenance Posture Improvement Project
MRE	meals-ready-to eat
MSC	Military Sealift Command
MSTS	Military Sea Transportation Service
MTBF	mean time between failure

MTMC	Military Traffic Management Command
MTMTS	Military Traffic Management and Terminal Service

N

NATO	North Atlantic Treaty Organization
NATS	Naval Air Transport System
NCA	National Command Authority
NDRC	National Defense Research Committee
NICP	National Inventory Control Point
NIRA	National Industrial Recovery Act
NME	National Military Establishment
NMCS	not-mission-capable supply
NORS	not operational ready supply
NOTS	Naval Overseas Transportation Service
NSC	National Security Council
NRA	National Recovery Administratrion
NTPF	near-term prepositioning force
NWLB	National War Labor Board
NYA	National Youth Administration

O

OCD	Office of Civilian Defense
OCS	Officer Candidate School
ODT	Office of Defense Transportation
OECS	Organization of Eastern Caribbean States
OMB	Office of Management and Budget
OMS	organizational maintenance squadron
OPA	Office of Price Administration
OPM	Office of Production Management
OR	operations research
ORS	orbital replaceable units
OSS	Office for Strategic Services
OTS	Officer Training School

P

PACAF	Pacific Air Forces
PAMPA	Pacific Command Movements Priority Agency
PDF	Panamanian Defense Forces
PLM	production-line maintenance
PLUTO	pipe line under the ocean
POL	petroleum, oil, and lubricants
POM	program objective memorandum
POMO	production oriented maintenance organization
POMCUS	prepositioning of materiel configured in unit sets
PPBS	planning, programming, and budgeting system
PSP	pierced-steel planking
PWA	Panamanian Defense Forces

Q

QM	quartermaster

R

R&D	Research and Development
R&M	reliability and maintainability
R&R	rest and recuperation
RAM	rapid area maintenance
RASS	rapid area supply support
RATS	rapid area transportation support
REMCO	rear echelon maintenance combined operation
RFC	Reconstruction Finance Corporation
RCM	Reliability Centered Maintenance
ROK	Republic of Korea
RVN	Republic of Vietnam
RVNAF	Republic of Vietnam Armed Forces

S

SAC	Strategic Air Command
SCAM	System Support Cost Analysis Model
SF	Special Forces
SOS	Services of Supply
STAR	Speed Through Air Resupply

T

TA	table of allowance
TAC	Tactical Air Command
TACAN	tactical air navigation
TACOM	Tank and Automotive Command
TACSAT	tactical satellite
TAMMIS-MEDSUP	Theater Army Medical Management Information System for Medical Supply
TAMMS	The Army Materiel Management System
TMA	traffic management agency
TOA	transportation operating agencies
TRANSCOM	Transportation Command

U

UHF	ultra high-frequency
UK	United Kingdom
UMT	Universal Military Training
UN	United Nations
USAAF	United States Army Air Forces (USAAF)

V

VHF	very high-frequency
VOR	VHF omnirange

W

WAAC	Women's Army Auxiliary Corps
WAFS	Women's Auxiliary Ferrying Squadron

WASP	Women's Airforce Service Pilots
WAVES	Women Accepted for Volunteer Emergency Service
WIB	War Industries Board
WPB	War Production Board
WRSK	war readiness spare kits
WSPO	Weapons System Project Office
WTO	West Pac Transportation Offices

Z

ZI	Zone of the Interior

Index

D

E

F

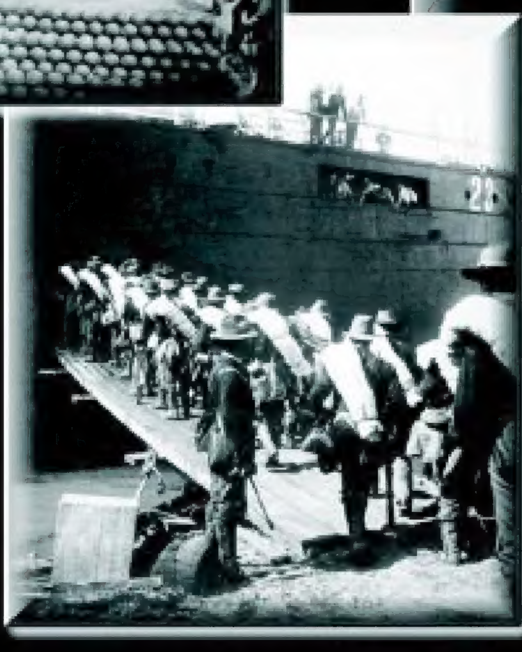
Q

R

S

T

U



AFLMA

air force logistics
management agency